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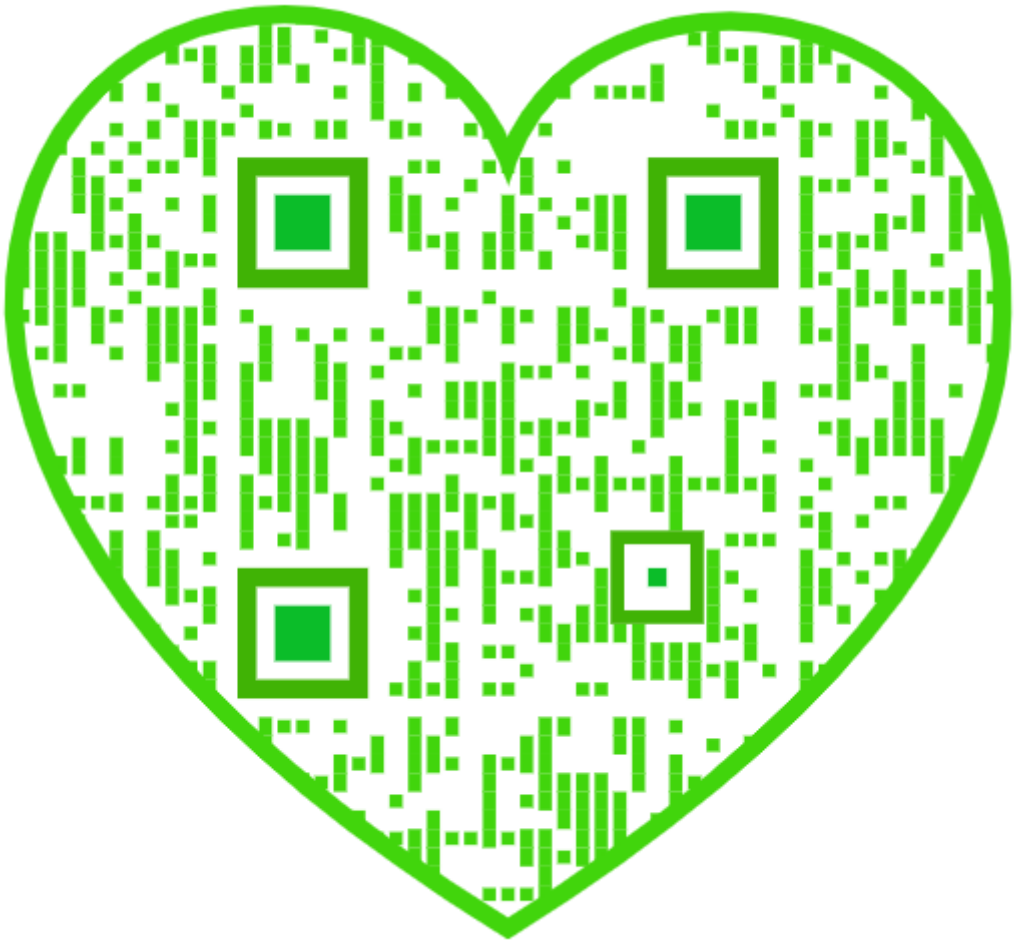

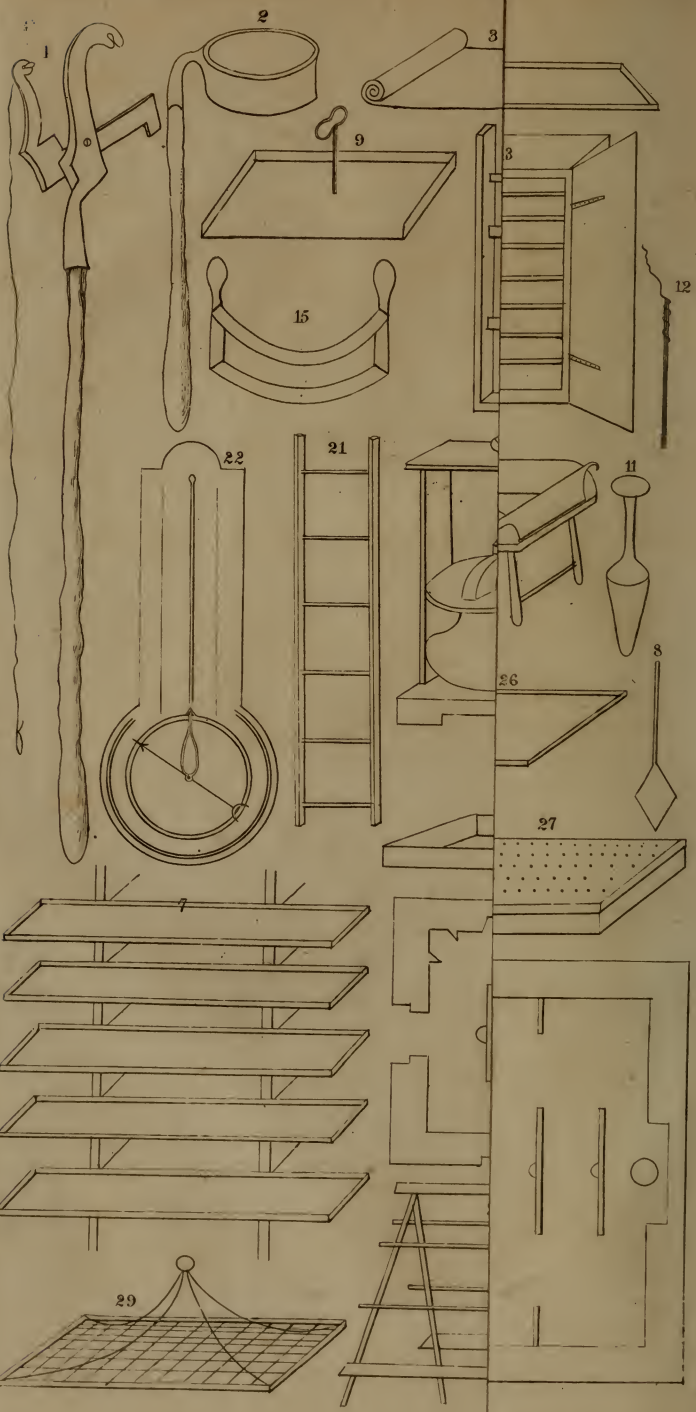
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THE

2nd Vol. H. Lyon

SILK RAISER'S MANUAL;

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499

OR

Marsh Capen & Lyon
Rec'd at Dept of State Jan 8. 1835

THE ART OF

RAISING AND FEEDING SILK WORMS

AND OF

CULTIVATING THE MULBERRY TREE.

15
No. 1571

BY M. MORIN,

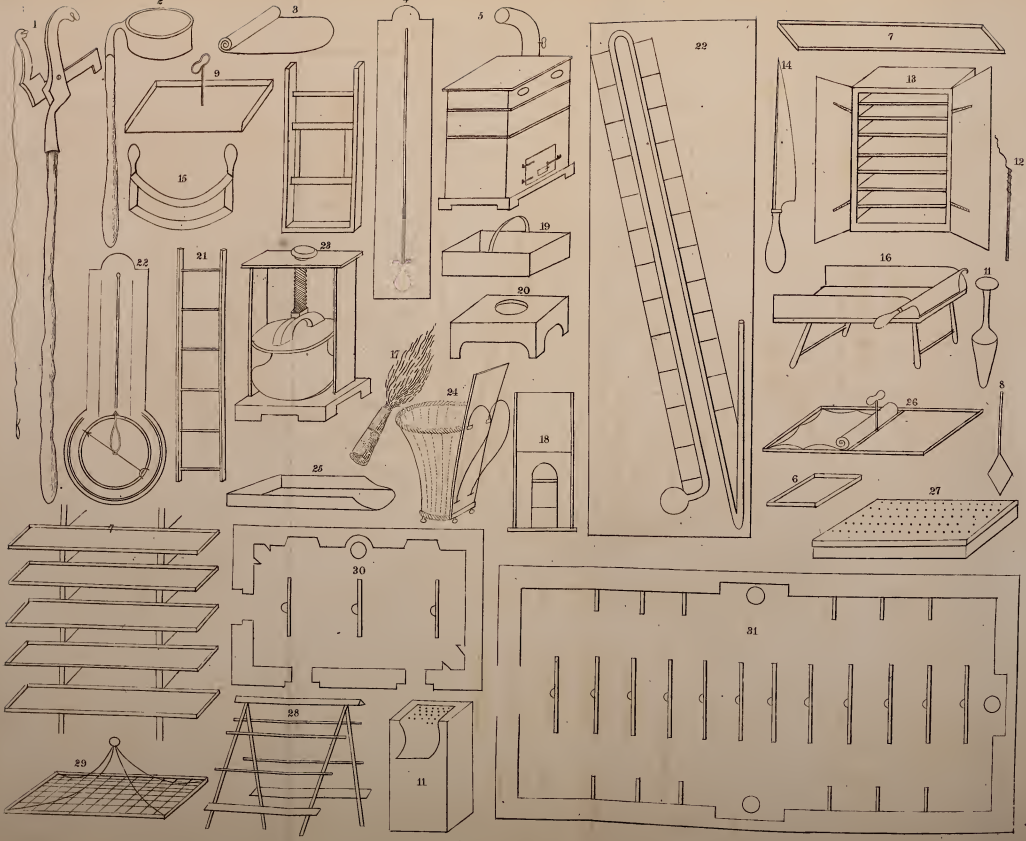
MEMBER OF SEVERAL LEARNED SOCIETIES.

TRANSLATED FROM THE FRENCH.

BOSTON:

MARSH, CAPEN & LYON.

1836.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TRANSLATOR'S PREFACE.

The present volume, it has been thought, may prove a valuable acquisition to persons engaging in raising silk in this country. Chapters 2d and 3d, in particular, have much useful information, not to be found in all the treatises. Chapters 4th, 6th, 8th, and 9th, also treat of matters necessary to be known, and of daily use in raising silk worms.

The book enumerates and describes many varieties of the mulberry, and explains the qualities of each, which make it more or less adapted to the health of the worm, and the production of silk of best quality and in largest quantity.

It also contains a very full and detailed explanation of the process of hatching, feeding, and taking care of the worms; drawing precepts on these heads, chiefly from experiments, made, from time to time, by persons experienced and skilful in the business; particularly using as authority on these points, the statements of Count Dandolo, relating to experiments made by him.

The plan laid down by the writer for the treatment of the worms, I know, has not been altogether approved in this country: and it is said they have been raised here with success on a different plan; that is, without regard to the careful maintenance of a high temperature in the atelier, and even exposing them to the changes of atmosphere. If any feel safe in pursuing

such a treatment, this chapter of M. Morin's book may be disregarded. They will no doubt find much information on other points connected with the business. But it is respectfully suggested, whether experiment has sufficiently tested the advantage or inutility of this course, in this country. It may be true, that in small establishments the worms have succeeded under a different course. But the evaporation of moisture from the worms, which is the chief source of disease, by contaminating the air, might not be great enough to prove fatal in a small colony of 1000, or of one ounce, when in a colony of several hundred thousands it would inevitably produce the death of all. It may therefore be very questionable whether in large establishments it may be safe to disregard the precautions which foreign writers well skilled in the business have considered essential to be observed. And, therefore, whether fires be not necessary as purifiers of the atmosphere, though the worms have been found to thrive in a low degree of heat.

INTRODUCTION.

In searching into the different authors, who have treated of caterpillars, and particularly of the silk worm, we find the following description of him in the Dictionnaire d'histoire naturelle of Latreille. "Under the family of nocturnals, having for their characteristics, wings entire, spread horizontally or sloping, and forming a triangle with their body; edge of the superior straight, and without curve at the base; upper antennulæ concealed, very short, in form of tubercles in some, and nearly cylindrical or nearly conical, diminishing gradually in thickness toward their extremity, in others: tongue none, or indistinct: antennæ pectinated, or in form of a saw, at least in the males: caterpillars in the greatest number with sixteen feet; the two posterior wanting in others, and replaced by two appendages resembling a forked tail."

But as these abridged details have appeared to us insufficient in the manual that we propose to publish, we have had recourse to the work of M. Dandolo, with which we have long been acquainted by the translation made of it. We there find, on caterpillars and silk worms, the following general description:—

"In all caterpillars the body is long, more or less cylindrical, formed, in its length, of twelve membranous parallel rings, which, in the motion of the animal,

alternately stretch and contract. They all have a scaly head, of a substance similar to horn, furnished with two very strong jaws formed like a saw, which move horizontally, and not up and down, as among warm-blooded animals. Under the jaws is placed the silk vessel, by means of which each caterpillar produces the silky matter. They have never less than eight feet, and not more than sixteen. The six first, of a scaly substance like that of the head, are fixed under the three first rings, and cannot lengthen nor contract sensibly. The others, of which the number may be two, four, six, eight, or ten, are membranous, flexible, and attached two by two to the posterior part of the body, under the rings which correspond to them. These last feet are those which transport the animal. They are armed with small hooks, sufficiently strong, proper to fix them easily, and enable them to climb. All the hinder feet disappear, whatever the kind of caterpillar, when it is changed into a moth or papilio, and only the six first then remain, which are differently modified. The orifice is placed under the last ring.

"The caterpillars breathe by means of eighteen openings, situated nine on each side of the body, by which the air enters, and goes out. Each of these openings is considered as the end of a distinct windpipe. Many caterpillars have eyes: some are wholly without sight, but they acquire it in the state of papilios. Many have the skin smooth: such is the silk worm, called also bombyx, a species of the order of lepidopteres, family of nocturnals, of the tribe or subdivision bombicites, of which the largest number spin a silky cocon, which has given them the name of spinning phalænæ (moths). Whatever the number of similar insects comprized under this denomination, it is the silk worm only, bombyx mori, to whose changes all these observations relate, since he has become of great importance, on account of the beauty of his cocons, the fineness and strength of the threads they make, and the prodigious increase he has given to

commercial dealings among all the people of the known world.

" The particular characteristic of caterpillars is to change their skin at least three times before arriving at the period when they shed the silk they contain, in order to be transformed into a chrysalis in the cocon or envelop that they have formed. In the greatest number this change takes place only three or four times; in others, from five to nine. It is called moulting, and often causes the death of a great number.

" The skin, in an animal that in a very short time increases a thousand fold its weight, would hardly be able to distend itself to the point to cover him entirely; but nature in her providence has extended over the body of the caterpillar the embryos of the skin of each moulting, which supply also the hairs or prickles with which many kinds are abundantly clothed. The animal increasing more than his skin can distend itself, it falls off, and is replaced by the second, which is more soft; this is detached in the same manner as the first, and is soon followed by a third, a fourth, and so on. At this period of the life of the caterpillar, nature excites in it a favorable crisis. He transudes from the surface of his body a humor which is interposed between the old and the new skin, and facilitates the passage of his body. The surface of the animal is then moist. After the last moulting each species of the caterpillar sheds its silk, and forms with it the cocon, or entrenchment in which the transformation to a chrysalis is to take place, and thence into a moth, the perfect animal which produces the eggs from which the caterpillars come, the greatest number of which subsist by devouring a considerable quantity of vegetable substances, the most of them serviceable to the wants of man. The manner in which they sustain their transient existence, that which they employ to preserve their embryo, the influence of the warm season in making them hatch nearly all at once, in developing them, in changing them to chrysales in the cocons, and bringing them finally to

the form of moths, would carry us into details useless as to the silk worms, which only interest us here."

"The last moulting being accomplished, the silk worm eats, in a certain number of days, a quantity of food almost incredible, and comes to his greatest point of growth. Arrived at this point his appetite abates, and ceases entirely. He then loses sensibly, by little and little, his weight and bulk. Disrelishing his food he seeks to change his place, to isolate, and put himself to repose. He perceives the necessity of voiding all excremental matters with which his vessels are filled, and even the membrane that envelopes them, and that serves, if we may so speak, for the lining of the stomach, and intestine. There then remains nothing of the animal but the silky matter, with more or less water.

"It is in this manner that the formation of the chrysalis is prepared, which is not accomplished till all the silk is shed, or the wrinkled exuviæ of the animal is separated in the cocon. And the quantity of silk generally furnished by the worms is not always in proportion to their bulk, for it is the middling sized that give more of it than all others. Finally comes the change into the perfect animal. The moth comes from his envelope. The males secrete the fluid that fecundates the eggs in the body of the females. The moth leaves in the interior of the perforated cocon all the membranes with which she was enveloped. The coupling follows immediately their coming out, and in proportion as the eggs are deposited by the female where the coupling has been, they lose, little by little, their natural vigor, and, this function accomplished, they both die.

"To end these general remarks, we add, that it is actually known, that, notwithstanding the immense quantity of caterpillars that appear every year in the spring, there are many means marked out by nature, to destroy a part of them, besides those that are in the hands of man. An immense number of birds eat them wherever they meet them, when they are hardly

out of the egg, and when full grown: the reptiles do not spare them: the cold kills them: and during winter, man, watchful to preserve his property, may easily search them out, destroy them, and consume them wholly by the fire. For this there is need only of an échenilloir (fig. 1.); and if he have waited too long, and they are hatched and scattered over the tree, he uses a warmer, or other vessel (fig. 2.), of casting or brass, in which he burns straw, sprinkled with sulphur, and which he raises, according to the height of the leaves, where need requires. This fumigation benumbs them, so that nothing more is necessary but to shake the branches, to make them fall, and easily destroy all that were fixed there."

But the most valuable of all the caterpillars is, without contradiction, the silk-worm, concerning which we propose to give all that is of common practice in the mode of raising them, either as an object of agricultural industry, or of commercial speculation; and if in this manual we do not seek to relate all that a special treatise on the particular treatment of them might do, we shall endeavor, in some sort, to omit nothing, and shall not pass without notice any details necessary for the direction of any one who intends to occupy himself with raising them: we shall endeavor to make known to him all that may facilitate the changes of age of the silk worm; that is to say, the moulting: all that may be capable of hastening his growth, and development from the moment when he is hatched, to that when he becomes a papilio, the end of his existence. We shall leave to the raiser all that particular localities may make necessary in the multitude of small details they may give occasion to. We shall speak, then, only of what is relative to the insect in order to obtain from him the most perfect of his products, and especially to a proper treatment of them during the few days of their short life. This will only be propagating the advice already given by Bonnafous, Dandolo, Latreille, Loiseleur Deslongchamps, Rosier, and Sauvages, who, we think, have arrived at a

theory in relation to silk worms, which is, in some sort, confirmed by experience. If our manual may serve to direct the raiser aright in all the cares and attentions necessary to the best manner of raising his silk worms, we shall have attained the true end of general and particular usefulness that we have proposed to ourselves in the collection of manuals already published on so many other subjects of general utility.

CHAPTER I.

OF SILK WORMS.

Before being acclimated among us, before they were found among the products offered to most of the agricultural and laboring families, the silk worms were not known except in China, where they cultivated from time immemorial the art of raising them, either in the open air or on frames, for the purpose of reeling their cocons, to manufacture, from the silk produced, all the stuffs necessary to the nature of the country. From thence they were exported to India; and by degrees the Asiatics, particularly the Tartars, the Persians and Arabians, became acquainted with this branch of industry. Some Indian priests, as we are assured, brought into Europe toward the beginning of the sixth century not only the eggs of the silk worm, but also the process of hatching them, of feeding them while in the state of worms, and of reeling their cocons. They established themselves at Constantinople, where the emperor Justinian made them an object of chief importance, capable of increasing the wealth of his people, who were then tributary to the

Arabians, by reason of the great quantity of silk stuffs they were obliged to buy of them. The encouragement which he gave to this branch of industry covered Greece with mulberry trees, from whence they were transported into Spain, Italy, France, and every where, where they expected to be able, by means of this tree, to succeed in the raising of silk worms, especially with a view to the advantages to be derived from them, or of the certain profits of their produce.

It was not till 1450, under the reign of Louis XI., that we saw mulberry trees appear, the silk worms, and men accustomed to raise them, whom this monarch had induced to come from Greece and Italy. In 1480 silk stuffs were made at Lyons and Tours. It is thence that those kinds came which were distinguished by the name of gros de Tours. In 1494, during the campaigns of Charles VIII., mulberry trees and silk worms were brought from Italy, which served much to give prosperity to the rich countries that border on the Rhone. Henry IV., in all the encouragements which he gave to industry, was one of the princes who most favored them, though his prime minister was far from agreeing with him. Under Louis XIII., they became entirely abandoned. Finally, Louis the Great appeared, and though his minister had begun badly, the premiums that he gave in the sequel to the planters of mulberry trees made them once more prosper, as well as the culture of the silk worms in all the southern provinces, and especially in Languedoc and Provence. Under Louis XV. and Louis XVI., and much more still during the first years of the revolution, the raising of silk worms in common

with all other branches of industry became paralyzed. Under the empire they had employment enough only to prevent being forgotten among other branches of manufactures: but now since the restoration, the habitations of the silk worm seem to have regained an importance and an increase much more considerable than they have had for a long time before.

Like all other animals translated from distant countries the silk worm must necessarily undergo changes at first insensible, but which in course of time have given place to races if not new, at least sufficiently different from those of their first stock. However this may be, the species which has been acclimated in Europe presents some slight varieties in the worms and their cocons, but this must be attributed to accidental circumstances. Thence it is easy to account for the moultings which some experience three or four times, as well as for the largeness or smallness of the cocons. Finally, though subjected to a temperature very different from that whence it has come to us, though dependent as it were almost absolutely on the cares which ought to be liberally bestowed on it, the silk worm easily preserves a strength of resistance, capable not only of making him surmount the difference and the changes of climate under which he is now bound among us, but even the dangers of the ignorance and of the unpardonable errors of the greater part of those who are charged with the care of him; for almost always it is good fortune, if you do nothing more than lose in the quality or quantity of cocons, while much oftener the whole brood is the victim. Notwithstanding all that may have been said of the quantity of the crops

of cocons that they have been used to make in Asia, although some are so bold as to assure us that they may be repeated once a month, and that they may also take place, without much trouble, at least twice in an ordinary year, in all our southern districts, this cannot be probable; and M. Dandolo, who, in whatever he does, may furnish authority, considers the bisennial crops only as capable of entirely destroying the mulberry trees; for he assures us that the trees suffer already very much by being stripped once only. How would it be then if this should be done twice? Indeed, if, as the Persians generally do, they cut the young branches of the tree, in our climates, to give them to the silk worm, it will be impossible that the sap can be sufficiently strong and abundant to renew them quickly enough in Italy, as well as in France, as it has been accustomed to do under a climate of a much higher temperature. Allowing that the leaves, separated from the tree by the small boughs are preserved more fresh, and may consequently better serve for the nourishment of the silk worm, it is nevertheless true that the crop of cocons that they obtain is not so great but that what we are used to gather would be nearly the same, in respect to its final result, that is to say in the quality and quantity of silk which we get from it.

As in climates where the silk worm originates, its cocon is in ours also, most commonly of a straw color, more or less inclined to white or deepening toward the orange yellow: none have ever been met with that were red, blue, or greenish, and when even the insect which produces it will be himself colored even to the deepest black, spotted with spots more or

less large and deep, the cocons that he makes will be nevertheless of a whiteness equal to those of the others. Every where the heat of the silk worm is the same as that of the place where he is put. When the temperature is increased or diminished his own corresponds to that which surrounds him. Therefore the differences of climate through which he has to pass will not be hurtful to him: nor can he be considered more in the class of cold blooded animals, than of warm blooded; for he is neither one nor the other. Like all other caterpillars he is provided with a very great number of feet. We count in him ten which are membranous, and six which are scaly, accompanied with eighteen organs that serve for respiration. We perceive besides a great number of folds behind his head, accompanied with a small horn on the back part of their rings. Their two reservoirs of silk are of a white color, drawing toward grey as they are more distant from the single thread in which they terminate.

It has been observed that even when suffering from hunger the silk worm never quits the mulberry leaf which served for his nourishment and where he is fixed: he remains there constantly attached, even when he has entirely stripped it. It is only in the first days after his birth, and when he has come to his maturity, or when he is sick, that he is seen to change places. During the whole of his short existence, he scarcely goes over a space of two or three feet at most. The duration of his whole life does not extend beyond sixty days, counting from the moment when he is hatched, up to that when he dies, after having deposited his eggs; and if by means of warmth his appetite and all his functions are more active, his life passes

much more rapidly still. The more lively his enjoyments are, the sooner are they terminated. In many ateliers, (or coconeries) they are made, to come to cocons in the space of forty days; and though it is frequently necessary in consequence of bad seasons to prolong them some days in order that they may complete their nourishment, we may also see them finish it in thirty-five days by keeping them at a raised temperature. But how much care, how many precautions is it necessary to take, that no damage may result, and to guard against all the risks it will have to encounter.

CHAP. II.

FOOD OF SILK WORMS.

It is now ascertained that only the leaves of the white or black mulberry can be used for the food of the silk worm. The first kind is the morus alba, white mulberry, a tree, which, in the climate of Paris, and in all the south of France, grows to the height of 25 or 30 feet, and in the southern parts of Europe as high as 40 and 50 feet, with a trunk from 6 to 8 feet in circumference. Its shank is divided into numerous branches, thick, spreading, forming generally a top more or less rounded. Its leaves are petioled, oval, a little hollowed into the heart shape at the base, pointed at the summit, indented on the edges, always

or very often, according to the age of the tree, or according to its variety, divided into lobes more or less deep and irregular. Their upper surface is a shining green, perfectly smooth, and the under has some hairs set on its edges. Its flowers are monoichal; some, males, disposed in cylindrical chatons, supported on peduncles, longer than themselves: the others, females, form round or oval chatons, rather short peduncles, which are succeeded by small berries of the same form, and of a red or white color. This kind, originally from China, is now cultivated and naturalized in the South of Europe, and also in many temperate countries in this part of the world.

The careful culture of the white mulberry has produced many varieties in this species. They are distinguished particularly into the wild and grafted. The first comprises four sub-varieties; the first, called feuille-rose, (rose leaf,) bears a small white insipid fruit, and its leaf is rounded like the small leaf of a rose bush, but larger; the second la feuille doree, (the gold leafed,) has a small purple colored fruit, and an elongated shining leaf; the third, la reine batarde, (bastard queen,) is distinguished by its black fruit, and by its leaves, which are twice as large as the rose leafed, indented in their circumference with the tooth at the superior extremity very much elongated to a point; the fourth is called femelle: the tree is thorny; it puts forth flowers before its leaves, which are divided into three lobes, like clover.

In the grafted mulberry we distinguish also four varieties: the first is la reine, (the queen,) with leaves shining and larger than any of the wild; its fruit is ash-colored; the second, la grosse reine, (fat queen)

has leaves of a deep green, and a black fruit; the third, la feuille d'Espagne, (the Spanish leaf,) bears very large leaves, extremely rough and thick, and a long white berry; the fourth, la feuille de flocs, (the woolly-leafed,) is of a deep green, very like the feuille d'Espagne, but less elongated and disposed in tufts on the boughs. Its fruit, very abundant, never comes to full maturity.

However, as it is very difficult to distinguish the wild mulberry, as they grow no where in Europe spontaneously, but we meet with them always cultivated, and the young plants that grow in the nurseries cannot be considered as wild specimens, since they come from seed obtained from trees that a long culture has more or less modified, and that they have themselves sometimes undergone new changes by the effects of the sun, and of the particular treatment which they have received in raising them—therefore it is, that in mulberry trees raised from seed we observe differences more or less considerable in the thickness and size of the leaves, and in their habit of remaining entire or dividing into lobes. And if these young trees were commonly not grafted before bearing fruit, we should find in them differences which might also serve to distinguish them; but otherwise, they must create a new variety for each particular seed; for the varieties rarely are propagated without differing more or less from the trees whence the seed is taken.

The only varieties of which it will be useful to make mention are those which, being propagated for a longer or shorter time from the seed, have been distinguished as exhibiting remarkable characters or qualities, and which, therefore pains have been taken

to multiply by grafting on seedling plants in the nurseries, which are called wild stock. Such are the following:—

Rose leafed mulberry, morus alba rosea. The tree is slender, with branches more extended than all the other grafted varieties. It may, however, attain a great height in the course of its life. Its wood is more solid and more compact; it approaches very nearly in its qualities to the wild stock. Its leaves are shining as if varnished, rarely lobed, borne on rose petioles; its fruit of a rose grey; its seed exhibiting some sub-varieties.

Roman mulberry—morus alba ovalifolia, oval leafed mulberry. The tree is large, and grows rapidly; its leaves are large and handsome, shining on the upper surface, whole and sometimes divided into three or five lobes on young and vigorous stems; its berries are rose-grey, or lilac. This variety is most prevalent in Provence, in the environs of Avignon, and in great part of Languedoc. It enters into the plantations in eighteen twentieths, the rose leaf in one twentieth, the grosse-reine and other varieties for the rest. It is agreed, however, that the rose-leafed variety produces a leaf of superior quality, which gives a good silk; and we are assured also that the worms which are fed on it are less subject to diseases, especially to those caused by a leaf too moist, coming from a soil too fertile. Why then is not the rose-leafed mulberry cultivated as much as it appears, on account of its good qualities, to deserve? It is because the nursery men, for their profit, prefer to cultivate mulberries of a rapid growth, that they may sell after two or three years from the grafting, while it requires two years

more for the rose-leafed variety before it has attained a size suitable to offer it for sale. In the second place, the greater part of proprietors mistake their true interest, not being willing to pay for this variety a higher price than for the others.

The grosse-reine mulberry—m. alba macrophylla. This tree grows large, but does not rise higher than the Roman. Its shoots are large, and its buds more near together. No other variety exhibits so large leaves; they are a little more plaited, and their petiole is short, compared to their size. The berries are large and white, very sugary, but they have not the agreeable acidity of the berries of the black mulberry, to which they are only comparable in size. They plant only about three or four of this variety to the hundred, and reserve its leaves to be employed toward the end of the feeding of the worms, and at the moment when they are on the point of moulting. This idea is drawn from the observation that has been made, that the worms void before being buried in their cocon: but this evacuation takes place also when the quality of the leaves given them at this epoch of their lives is not changed: since the worm must necessarily disencumber himself of all excremental matter before being transformed: thus it is very rare that we find fæces in the cocons, and we always find the skin of the worm, which is not injurious to the quality of the silk as would be the fæces diluted with warm water at the moment of drawing it from the cocons. In consequence of an opinion that the leaf of the grosse-reine mulberry purges the silk worms, it has not commonly been given them in the first ages of their life; and this leaf is often refused by purchasers: many persons

only use it on failure of others. Is this opinion well founded, or is it an error? What is certain is, that in general the large leaves are more watery and contain less nutritive matter, and that from thence must result injury to the digestive faculties which must have an influence on the vigor of the worms.

Langue de boeuf (ox-tongue) mulberry—m. alba oblongifolia. Its leaves are large, shining, not lobed, almost twice as long as broad. This variety is cultivated in the Cevennes; but is not much esteemed. They prefer that called colombassette, which seems to be a sub-variety of the rose-leafed mulberry of Provence.

The Dwarf mulberry—morus nana. This is a variety produced from seeds, and which reproduces itself sometimes in the same manner. The tree is a little larger than that known under the name of Constantinople mulberry. Its leaves are very like those of the grosse-reine, and its berries are white. The dwarf mulberry will be advantageously cultivated, because its boughs are very near, and a tree of small size will furnish as many leaves as another mulberry three times as large: we can plant of them also a much greater quantity on the same extent of land.

M. alba integrifolia—a mulberry with leaves always whole and shining.

M. alba integrifolia obscura—leaves always whole, and not shining.

M. alba semilobata et coriacea, with large leaves, tough as leather: commonly its leaves are divided into from two to five lobes.

Lobe-leafed mulberry—m. alba lobata. Its leaves are divided as far as the centre into from three

to five lobes. This mulberry has three sub-varieties: in one the leaves are very large; in the second they are of middling size; and very small in the third.

Morus laciniata. This variety has its leaves divided into five deep lobes, of which the middle one, larger than all the others, is itself divided into five or six alternate lobes. To these five last varieties, which are little known in the culture on a large scale, we must also add a mulberry cultivated now for some years past in the Jardin du Roi, and brought from the isle of Bourbon by Capt. Philibert. Its leaves are whole and scarcely marked, nearly dull on the upper surface, more decidedly pubescent on the lower than other white mulberries. Its parenchyme or pitch is rather small and dry. A young stem has already passed the winter unprotected in the ground without injury from the cold. It will be advantageous, to cultivate this variety, if its leaves do, as we are assured, supply to the worms of China the best quality of silk.

Though we have all these varieties, the botanists add also the morus *tartarica, m. †Constantinopolitana, m. ‡rubra, m. §indica, m. ||latifolia, m. ¶australis, m. **mauretiana, m. tinctoria, m. ††papyrifera; indeed they enumerate as many as eighteen kinds of mulberry, all of foreign origin. They are considered as apetalous, and dicotyledonous plants, family of urtices, class monoecia, tetrandria L—. J—. Apetalous dicotyledon, species having male flowers collected in aments; stamens separate from the pistils. Order III. Urtices. Calyx four parted, divisions oval and

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*Tartar. †Constantinople. ‡Red. §Indian. ||Broad leafed. ¶Southern. **Morettian. ††Japan paper, m.

concave; corolla none; stamens four, situated between the divisions of the calyx; filaments erect, subulate longer than the calyx, and supporting the anthers. Female flowers (growing sometimes on the same individual, and sometimes on a separate plant) have a calyx with four leaves, rounded, obtuse, and persistent, the two opposite exterior ones approaching each other; corolla none; pistil naked; germ, heart shaped, surmounted with two oblong, subulate, rough, strong styles, terminated by simple stigmas; no pericarp; its place supplied by the calyx, which is converted into a fleshy succulent berry, containing one, sometimes two pointed oval seeds, of which one is usually abortive; perisperm whitish, fleshy, of the same form as the seeds, receiving the embryo reversed, bent into hooks. Cotyledons oblong foliacious, smooth, narrow, bent one over another. The upper radicle is cylindrical. Distinctive character, monoecial flowers. Calyx four parted, corolla none, stamens four, styles two; pericarp none; calyx changed into a fleshy berry. The female flowers are numerous, collected rather loosely in a common receptacle. Each germ is changed into a succulent berry, the union of which forms the fruit we call mulberries—white, red or black. The trees are whitish, milky. They delight much in sheltered places, and warm grounds, and rise to a height more or less considerable. They extend their roots deep, large and branching. Their wood is of a yellow citron color, more or less deep; their bark rather hard, covered with greyish rough places; their leaves alternate, often lobed, accompanied with caducous stipules toward their base. They have a very considerable power of vegetation, and put forth rapidly.

When grafted, they die after twenty-five years, while the mulberries not grafted, the wild stock continue, even through the hardest winters, for one and sometimes two centuries. We meet them even in the northern regions. Every where, where are silk worms, the mulberries are found; but it is only in a rather elevated temperature that we can flatter ourselves to see them prosper. There the thorough maturity of its leaves, by means of the warmth, may promise all the qualities requisite to the nourishment of the worm. Finally, if he has need himself of a constant and equal heat, it is only in tropical climates that it will be possible to unite both, and the raising of the silk worm will deserve to be justly considered an important enterprize.

Since some experiments made on the leaves of the grafted mulberry, it has been known that in a hundred ounces, thirty are evaporated by drying; that the same quantity of those whose leaves are deep green loses thirty-one, and the double leaves thirty-six. Indeed, when the leaf of the mulberry is young, new and tender, it contains a large part of watery matter; the more it grows mature the less it contains. The worms also in their first and second age let much moisture escape from them, and are constantly surrounded with vapor, which they exhale in proportion to their bulk.

In the beginning of raising silk worms in Europe, they used only the leaf of the black mulberry. But when the white mulberry had been cultivated under the beautiful climate of Greece, it was not difficult to procure it from thence. It offered, among others, some advantages that made it altogether preferable.

In the first place, the putting forth of its leaves more early, allows of using it much sooner, and, by consequence, of obtaining the cocons some time before the greatest heat of the season. Secondly, the abundance of the leaves that may be taken from it in a shorter time; the disposition of them, thicker: in fine, they attribute also to this species the excellent quality of silk which comes from worms fed on its leaves, although the warmth contributes very much to it. However, the opinion seems yet to be in favor of the influence of the mulberry on the worm which feeds on it, and the silk that comes from him; for, in a leaf, we distinguish the parenchyme, the coloring matter, and the watery particles, all which can scarce serve for food, much less be considered nutritive. It is therefore only the saccharine matter that expands the insect, and makes him grow, and, developing the resinous matter which fills his two reservoirs, brings him at last to make his cocon.

In general, the leaf of the black mulberry which will be hard and like leather, though given abundantly, cannot nourish the silk worm like that of the white, and will produce only a coarse and heavy silk, but abundant; while the other, planted in suitable land, furnishes a silk of excellent quality, as handsome as it is pure. It is all the other way if we put it in moist and fertile lands; the silk is not only less abundant, but also of a quality very inferior. So, the less good the leaves are, the more must the worm consume of them, and the greater attention ought to be given to watch that he does not become sick. The less of the resinous substance they contain, the smaller will be the cocon, though the worm comes to his greatest enlarge-

ment. The best of all the leaves of the mulberry is that commonly called double leaf—small, of a deep, blackish, and shining green; it contains a less portion of water. It should be preferred to those which are large and heavy and produced by vigorous trees in their season of greatest strength; for it is well ascertained that in proportion as trees grow older do their leaves become tender and nutritious to the silk worm. And, comparing those which have been grafted, to the wild, it is the last kind which produces in its leaves the nutritious quality and has the elements of silk in greatest abundance; though the grafted, when old, yields a quantity of white berries much more sugary and in greater numbers; and in places where they sell its leaves they take care not to separate the berries from them, though the worm does not eat them.

Particular care must be given to separate all the leaves which have on them either any moisture occasioned by dew or rain, or the mucous-saccharine secretion that we sometimes find on them, and which is considered a sort of manna,—because that in either case they may be unwholesome and make the worm sick. Indeed the leaves of whatever sort, after they have been selected must be kept sheltered from moisture and light, in a place of a temperature constantly equal, to prevent them from acquiring, by being heaped together, any perceptible and rapid action of fermentation, which is always manifest when they have been gathered in warm weather and in panniers or bags, where they have already undergone the first degree of pressure. It is necessary therefore to take great care to have near the coconry, (atelier) a place where they may be watched during two or

three days, taking the precaution to remove them, if necessary, from time to time, to prevent any change in them. And even when they become mouldy before being gathered, we need not regret it, because the worm eats only what remains of it uninfected: it is enough to give them a greater abundance of it, in order that they may not be obliged to seek nourishment from them.

In warm countries, in Italy especially, and in all those parts of France adjacent to it, in the southern departments, mulberries may thrive, and give nourishment to the silk worm in abundance; but care must be taken not to strip them but once a year, if we would preserve the trees a long time, and particularly before the second sap, so that the leaf may be renewed, and we may not risk the loss of it, by gradual decay or by a total drying up of the branches and trunk. M. Loiseleur Deslongchamps has pointed out still more varieties of the white mulberry, interesting in view of the qualities they possess for the nourishment of silk worms. As they are not much known we shall give an account of them.

The first is la colombassette. This is the most ancient known variety; its leaf is small, slender, thin, very soft; the silk worms prefer it to other kinds. The berries at maturity are yellowish and very large. The trees are the largest of the species, and of the longest duration.—The second is the rose. Its leaf is a little larger, and of rather deeper green than the colombassette: it is as good for the nourishment of the worms. Its berries are reddish, and of the same size as those of the preceding variety.—The third is la colombasse verte, exhibiting two sub-varieties, which

are designated by the names of the large and the small colom. verte. Its leaves are not so fine as the two first, but they are larger and more elongated. Its berries are blueish, and not so large as those of the colombassette and the rose.—The fourth, la rabalayre or traineuse, a variety much resembling the colombasse verte, but which is essentially distinguished from it, in that its buds are farther apart, and of consequence the tree produces less leaves, and as it is less exhausted in producing foliage, it grows large and developes itself rapidly. The tree bears few berries, and they are of the same color as those of the colombasse verte. The fifth, la poumaou, or la pomme; its leaf is large, rather fine, of a round form. The tree produces scarcely any berries, and although it does not throw out shoots as long as the other varieties, it furnishes a sufficiently large quantity of leaves, because its branches are leaved in their whole extent. The sixth, la meyne: this variety has the greatest resemblance to the preceding, both in quality and size. The form of the leaf is not so round. The seventh, l'amella, or l'amande. The leaf of this variety is oval, much thicker, and heavier than that of all the preceding varieties, and more difficult to gather. It suffers less than those from the cold, from winds and dew which produce mildew or mould, a disease of the leaf which causes much loss. The tree yields not scarcely any berries. The last is la fourcade, or la fourche, a variety whose leaf is nearly round, and very abundant, by reason of the nearness of its buds. The ninth is la dure: it bears this name because its leaves are really hard, not for the worms, but for detaching them from its branches. It requires

strong arms to gather them; and laborers for the most part, to make light work, adopt the mode of detaching them one by one. Its leaf is nearly round, rather fine, and is produced as abundantly as the fourcade. The tree does not produce scarcely any berries. It grows grubby, if its culture is in the slightest degree neglected. The tenth, finally, is l'admirable. This variety exceeds all the others in the size of its leaves; it also produces more of them, by reason of the nearness of its buds. Its leaves are strong, and thick; they are not given to the worms, till after they have passed their fourth moulting, because they then have strength, and appetite, necessary to eat them without injury. When this tree is set deep, and well cultivated, its leaves attain an extraordinary size. It is not rare to see them from ten to eleven inches long, and eight or nine broad. The tree produces few berries, which are small, and of a grey color.

Of these ten varieties the colombasse, and the colombassette, are those whose properties are most favorable to the health of the silk worm, and which cause them to produce, at the same time, the most silk, and of the best quality. However, in general the preference is given to the poumaou, the meyne, the fourcade, l'amella, and l'admirable, because these varieties produce more leaves.

CHAP. III.

OF THE CULTIVATION OF THE MULBERRY TREE.

We have already said, that for a long time the leaf of the black mulberry only was used for the feeding of silk worms; and also that the white mulberry was preferred to it, because its leaves being generally composed of a fibrous texture, of a coloring matter, of a saccharine matter, the only nutritive part, and of a quantity of resinous matter heavier than silk, but, at the same time, stripped of its animal part, of a like nature with it, it could not be doubted that the resinous part was the only one that went to form the silk, as the saccharine contributed to the animal fluids that were the life of the insect. It is easy to conceive that the kind of leaf which contains the most of these elements under the least volume of parenchyme, or indigestible fibres will be the best food that can be given to the silk worm. We shall speak then only of these two species, and, beginning with the black, shall dwell more particularly on that of the morus alba, or white mulberry.

The black mulberry, morus nigra, m. fructu nigro, is a tree which, according to the climate where it is

planted, may grow to a height of 20, 30 and even 40 feet, forming a head more or less rounded, divided into branches and crooked boughs, bearing on them short and thick shoots. Its leaves are petioled, heart-shaped, pointed, indented, without hair and rough to the touch on the upper surface, pubescent on the lower, often entire, sometimes divided as far as the centre into three single lobes, which sometimes are sub-divided into many other small secondary lobes, as if cut. The flowers are male and female: the first are dioichal, with oblong chatons, solitary, or sometimes collected two or three together ; their axes and calices pubescent: the second disposed in oval chatons, with peduncles very short, to which succeeds oval berries, oblong, more or less thick, of a blackish purple color, of a pleasant flavor, acidulous and refreshing: the flowers appear in June, and the fruit from July to September. We are assured that it is native to Persia, but the time of its introduction into Europe, is entirely unknown: however, there is reason to think that it must be very ancient.

However this may be, the berries have a taste slightly sugary, and acidulous, which makes them sought in their season. A little less agreeable than many other of the summer fruits, they must be taken at the moment of their perfect maturity, for if taken too soon they are sour, if too late they have suddenly an action of fermentation: it is only when they may be detached from the tree by giving it a slight shake that they are truly good to eat. Often in an excessive abundance on the same tree, they are not ripe till toward the middle of July, and are prolonged successively till the end of September. Considered in rela-

tion to their use, the berries are assuaging and even laxative. They are not much used, except in medicine prepared in form of a syrup called by their name, and which is often employed as an efficacious remedy in many circumstances. The berries when pressed, if the sugar obtained from them is mixed with water, and subjected to the necessary fermentation, produces a vinous liquor, sufficiently alcoholic, and which passes very rapidly to an acid state. Dealers are accused of coloring wines with the sugar of the mulberries; but this coloring matter must form a deposit, disagreeable to meet with in drinking. The bark of the black mulberry is of a bitter and acrid taste nearly insupportable. The attempt has been made, and with success, to make paper from it.

Its leaves nourish the silk worm as do those of the white mulberry: in many countries they do not even cultivate any others for this object. Its wood may be used in joiners' work: it is easily turned. In the environs of Paris it grows scarcely beyond 25 or 30 feet high: it is rarely met with larger. For the most part they give nearly in every two years a crop of fruit much more abundant than in the ordinary year. In the first case the female chatons are very numerous, the male rather rare; it is quite the contrary in the second case, but the leaves are much more nourishing. Produced from the seed it is much more strong and vigorous; but it is usually only propagated by layers and slips, which is done commonly at the close of winter, and toward the commencement of spring. It is most frequently planted in orchards, gardens, sheltered places near houses, and in yards, because fowls are extremely greedy of the berries

when they fall. In hedge-rows under walls they do not require either space or cultivation, as in the open ground.

The white mulberry, morus alba, cultivated all over Europe, though indigenous in China, is a tree which grows to a height more or less considerable: its roots are close, compact and ligneous, extending themselves rather deep in the ground, whose inner sap is of a deep lemon color, and is deepest towards the centre. Unequal, rather deep crevices are furrowed through the whole extent of the bark, to its branches, rarely straight, unequally scattered, the direction of which toward the top spreads to take the rounded form. The small boughs that spread from it carry with them a greater or less quantity of leaves narrowed in the form of a heart, and indented quite to their points; often single, and rough to the touch. They are in one or more lobes. The flowers they produce are monoecial and in chatons, which bring forth a small sugary fruit in form of a whitish or slightly purpled berry: they appear in April, and even at the end of March in the southern countries. In cold countries they do not appear till May.

The first plantations of white mulberry in France were limited to the banks of the Rhone; but after trials had been made of it in Dauphiny, in Languedoc, and Provence, the mulberry succeeded perfectly in every region where it was planted. Indeed, although according to the manner of planting, grafting or cultivating it by different processes, it may perhaps be altered or modified to something not resembling its original, it is so divided that it would be very difficult to define its divisions according to the characters which it exhibits;

nevertheless among the grafted mulberries and those not grafted there are found four varieties, which it is important to point out and make known.

Thus, among grafted mulberries we distinguish first the kind designated under the name of feuille reine luisante (shining queen,) much larger than all others and especially than the wild mulberry. Its fruit is of a grey and a blue color, more or less deep, approaching to the slate. 2d. that called feuille grosse reine, (fat queen,) of a very deep blackish green: its fruit is of a handsome black. 3d. that which is called feuille de Espagne (Spanish leaf,) thick, large and broad, with a white fruit more or less elongated. 4th. finally, that known by the name of flocs, (woolly) which produces a considerable quantity of berries which scarcely ever or very rarely ripen. (See preceding chap.)

Among the ungrafted, very improperly called wild mulberries, (for it is proved that it cannot produce itself, since a seed taken from the tree, and placed in a condition necessary to produce a tree, will only come to an abortion,) there are also four distinct species; 1st. that with a rose-shaped leaf, slender, indented and rounded into a form somewhat larger than the leaf of common rose bushes, with a very small white fruit. 2d. the gold-leafed, with leaves shining, and elongated toward the middle, the fruit of which becomes rather black than reddish or purple. 3d. that called la reine batarde, (the bastard queen,) with large unequally indented leaves, and the fruit of which is extremely black. 4th. finally, la femelle, (the female,) the fruit of which appears before the leaf, and in which the whole surface of the tree is covered with thorns, (see preceding chap.)

To cultivate mulberry trees, and to sow them with all the conditions essential, in order to see them increase with a fair yield, and to have them strong and developed in such a manner as safely to count on their products, one of them should be chosen in its full maturity and entire. By shaking it a few minutes, we gather all the finest of the berries, among those which have fallen, to put them to dry in the shade, and in a place free from all moisture; then they are put into bags of thick brown paper, or in a bottle, to preserve them from insects. At the sowing time they are to be soaked in water, the pulp broken between the two hands, and washed several times. When this is done in autumn or toward the end of winter, it will be perfectly the same thing, provided that we choose for it a ground improved by many former cultivations, and which is not too much subject to moisture. After having prepared beds, greater in length than in breadth, laying them out by a line, intersected by furrows two inches deep, crossed by others in parallel lines whose points of contact meet at a foot distance one from another, in which the grain is sowed rather thick; the rake is to be passed over to cover them, some horse-manure spread over the whole; from time to time, they must be weeded during the heat; and dry weather, they must be watered, and the surface must be from time to time renewed carefully. The plants will soon show themselves, when they must be thinned, if growing too thick, putting them, as near as possible, two or three inches apart. After having let them come to the size of a goose quill it will be necessary for at least three years, counting that in which they are sown, to tend them during the whole

time in the following manner: At their first appearance they must be thinned: the second year they must be pruned of all the small branches up to a foot from the ground: from time to time they must be watered; they must be weeded with a weeding-hook, have frequent tillage, must be retrenched of all the superfluous branches, and all that are unthrifty, poor, or grubby must be entirely cut off. The best are to be grafted after having transplanted them to another place, dug about and tilled anew, and set at a distance of at least three feet from one another. Some put them only at two feet; but particular attention must be given to preserve all the small branches of the roots from contact as much as possible; then furrows are to be made, or trenches deep enough to place them in a suitable position. For grafting, those must be chosen which have been sowed six months beforehand. If we wish to make a graft by budding, it is to be taken of six lines * in diameter for the size, and at six or eight inches above the ground, for it is only the old that can be grafted en flute.

But it is an important question whether they should or should not be grafted. Observation proves that the mulberry trees not grafted, last for ages, comparatively with the others, though they do not yield leaves so handsome. The length of time during which they produce them may certainly compensate for the advantages of the grafted tree, which, after twenty or twenty-five years in which it has produced, ends by decay, which obliges us, so to speak, to grub them up in order to replace them with others. Thus the advan-

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* A line is one twelfth of an inch.

vantages which we derive from the grafted trees are not so great, as we should wish to say they were; for though the grafted trees come on much sooner, than those that are not grafted, they arrive much sooner also, to their termination: and all who have been occupied extensively in the culture of the silk worm have always preferred the leaf of the ungrafted or wild mulberry, to that of the grafted, although handsomer in appearance; and the product of the crops yielded by the first, differ much in their quality from all those produced by the use of the second. "Beside the superiority belonging to the wild, in the quality of its leaf, and its suitableness to produce a finer, and more brilliant silk, it has also over the grafted the advantage of an earlier development of its buds, and of being perfectly wholesome to the worms in their first age. As, however, the trees of this kind have not been generally much multiplied, perhaps it will be most advantageous to cultivators having but a small number, to reserve its leaves for the worms in the fourth age. It is at the time when they reach this age, that ordinarily comes on the season of suffocating heat, which, relaxing the organs of the worms, renders very difficult the digestion of food such as is obtained from the leaf of the grafted mulberry, too abundant in fibres, liable to a dangerous fermentation in their vessels, and too destitute of silky matter.

"A blind cupidity has however caused the adoption almost universally of the custom, introduced about 1720, by the inhabitants of Alais, to cultivate only grafted mulberries. They are sooner in full bearing than the wild: they produce leaves larger, thicker, and consequently heavier: their boughs are

more loaded with berries, which adds also to their weight. Here are the reasons of a preference, which by compromitting the long succession of crops, and deteriorating the quality of the silk, has dearly bought the advantages which it brings to those who sell the leaves. Though the disadvantages may be less in the meagre lands of hills, than in moist and fertile plains, where the leaf acquires a quality little resinous, but very watery and sugary; yet the advice to return to the use of the wild, ought not to be more disregarded by the high countries than by the low lands.

"Likewise, the best quality of leaf is that from trees brought to maturity in a soil loose, light, and sandy, but not too dry, and rather dry and poor, than moist and strong. Every one can, on these data, measure the degree of goodness of his leaf, and understand beforehand the influence it will have on the success of his worms." (Dictionnaire d'Agriculture.)

Finally, of grafted and not grafted, the mulberries cannot, in the first case, be transplanted to the place they are to occupy, till after their third year, the others at about five or six years. For this there should be made during summer, trenches, two and a half feet deep, six feet full in breadth, which should be left open till February or March: then the tree is placed therein with all the care and caution we have already recommended above in speaking of the nursery; the earth about its stem should be watered, and be often turned up afresh, and no other plant suffered to spring up in it. Generally, we should transplant only handsome, well-selected subjects, and which especially are not old in the nursery, crooked, knotty,

or mean looking. They should be transplanted as soon as possible after being removed from the ground, without cutting off any thing, and without even removing the earth which may remain on their surface. In case the planting be not effected soon enough, the roots may be surrounded with straw wrapped around them. It is on the good treatment of the tree, after it has been transplanted, that depends the time when it may be stripped for the feeding of the worms. It is advisable not to be in haste to do it, and to wait till at least the fifth year from its planting. By attempting to enjoy its product too soon, we check its growth, and risk the loss of it. Those indeed who wish to have its utmost vigor, strip it only once in two years. Moist or marshy lands should be avoided. It is important to choose, on the contrary, those which are light, not too moist nor too dry, and, if possible, gravelly, like those we meet with in Provence, and Languedoc. The spaces ought to be from five to six feet between each tree and the path or border of the field. The hatchet or pruning knife, should not be used but to give the tree a suitable form and to prune off all the useless branches. Well directed and taken care of, they become magnificent, especially if they are carefully handled in gathering the leaves. It is recommended even to separate the leaves with shears, in order to avoid lacerating them. Though with an edged instrument it may require more time, and it may be necessary to let them fall on the cloths to be heaped up afterwards, it is nevertheless true that this method has some real advantages, in that the tree suffers less, and that the leaves in gathering are not

liable to be damaged in any manner, as happens always in enclosing them in baskets or bags.

For more ample details on the cultivation of the mulberry, the works of Bonnafous, Duhamel, Loiseleur Deslongchamps, Rozier, and Sauvages, who have written particular treatises, may be consulted. We shall in them find confirmed,

1st. That it is of the first necessity, to cultivate those mulberries only that produce good leaves, and that it is on them, chiefly, that the quality of the silk depends.

2d. That with a quantity of leaves of ungrafted mulberries compared with those of others, the advantage is found in the cocons produced from the first.

3d. That the hatching of the eggs must take place at the time of the appearance of the leaves, by preparing them by means of a stove.

4th. That, especially in the first age, the leaves must not be given to them, unless gathered some hours after sunrise, to avoid the moisture of the dew.

5th. All leaves mildewed, rusty, mouldy by the rain, by fogs, must be rejected. Only the fresh, good and dry, must be given to the worms.

6th. That the strongest must be reserved for the latter time of the feeding of the worm: because then he has acquired strength to digest them.

7th. That it is necessary to procure as often as possible a sufficient supply of provision, either purchasing it by the weight or judging by estimation from trees of known quantity.

8th. To avoid the odor exhaled by the leaves, they should not be placed near the frames, because the odor of the worm is already sufficiently strong.

9th. Finally, all leaves gathered from sound, vigorous trees, which have not been exposed to humidity or to the heat of the sun, given to the worms when in all their freshness, are those which prove best, to make them succeed.

CHAP. IV.

OF THE HATCHING OF SILK WORMS.

Among the first things to be observed in hatching the eggs, after having separated them from the cloth or paper on which they have been kept since they were laid, the most important is to submit them to a temperature a little raised, as much to produce vigorous worms, and to preserve them susceptible of fulfilling the end designed for them, as to bring them forth all at once. For a long time past recourse has not been had to the heat of dung-heaps, of beds, of kitchens, or other places: now stoves or hot-houses are made like those used by gardeners to obtain flowers in winter: from the moment that the eggs are exposed to heat, they undergo all together the same change of condition; and whatever the number may be, they come forth nearly all at the same time. It is

necessary during the time to give them continued attention and great care, for without it the whole brood may be lost or suffer injury. Thus, after being provided with thermometric apparatus, and having described the stove for hatching them, we will explain the manner of their coming out.

1st. To prepare eggs for hatching, it is absolutely necessary that they should be well impregnated, and particularly, well preserved till the end of April or first of May. For our climate, linen cloths are used, which are immersed for six minutes in water, to dissolve the mucilaginous matter that they retain on their surface: they are left to dry for ten minutes on a table and all the eggs, are to be scraped off with an instrument rounded and cut as described, (see fig. 3.) which are thus detached with much ease: they are heaped up in order to be poured together, till none remain on the linen. It may be done in any vessel in half an hour. A small quantity of water is poured over the eggs before separating them, which serves to wash them. We take off all that rises in this operation. Five minutes are sufficient for it. It has been observed that the eggs collected in a cold and moist temperature turn yellow, and sink to the bottom of the vessel. The whole are poured on a sieve or piece of clean linen, to separate the water from them and keep the eggs apart. After having collected as many as are thought necessary, they are to be sprinkled with weak wine,—red or white. Some do this again with a new water, and this makes no perceptible difference; but it is not well to leave them too long in the wine, because it hardens them much, and retards their birth. They must be taken out in ten

minutes. The love of gain only has led those who trade in them to immerse them in very dark colored wine. Thus they color them like eggs well impregnanated, though nothing can be obtained from them; a fraud against which the purchaser must be on his guard. Thus, after having well separated them by a gentle friction, they must be stirred up, shaken, poured off quickly, and we easily collect the heaviest, which are all good. They are then to be taken out of the wine and spread again on new dry linens till they become completely dry,—which will take about 48 hours. They are to be kept spread out in beds of six or eight lines thick, in earthen or porcelain plates, till we wish to hatch them. They must be kept sheltered from light and, moisture, and provided the temperature be from six to twelve degrees of Reaumur, this will be sufficient. All these attentions will only require an hour and a half.

2d. In order to be able to establish the degree of temperature suitable to hatch the silk worm and to regulate it by keeping it constantly equal, it is necessary to have at disposal and in sight a thermometer well graduated and well made. For this, one of mercury should be selected; however, as they are very dear, if it is desirable to have a large one, M. Lagarde, optician, at Paris, quai de Gevres, n. 10, au troisième, makes them of spirits of wine with which it is impossible to commit errors. He has constructed them according to directions given him by Mr. Dandolo himself, from a physician at Milan; for "the distance marked for the state of the glass at boiling water on the common thermometers is too small; the degrees on them are too near, which sometimes causes errors.

To avoid this inconvenience, I have caused to be constructed for the stove a thermometer with a long scale, the distance from one degree to another being equivalent to that of ten degrees in the common thermometers: by this means I have had each degree divided into five fractions, which are easily distinguishable even at considerable distance. We can thus perceive the least alterations in the heat of the stove. These thermometers have a mark, indicating where the spirits of wine ought to stop, which should be colored red I observe that if I have had them made of spirits of wine, it is because those of mercury were too costly. Otherwise, when they are made by a skilful workman they are sufficiently exact." In order therefore to operate in a manner as certain as it is possible to do, the only thing is to procure thermometers like those of which mention has been made in this article.

3d. As to the arrangement of the hot-house let a small room, of twelve feet on every side be used, the walls of which are very dry, with a stove on one of the sides or in the middle, made of baked clay or of bricks very small, and which may be heated with little fuel and gradually, so that it may retain its heat in a manner to prolong it as much as possible, or may be increased or diminished as may be required, without causing smoke in the interior (fig. 5.): let several thermometers be placed there in different parts, to see if they agree, and if the heat is every where the same. For, if it is constantly the case that the eggs of caterpillars only become hatched because they are placed in an atmosphere warm enough to open the seed, the silk worms cannot certainly get in our climate the degree of heat which they have in that whence they

originate; it is then of absolute necessity to supply it to them, in order to make them all hatch at the same time, and that they may be developed in the same manner. Hurdles of ozier should be arranged there beforehand, or boards placed near the wall by means of cross-pieces fixed in it, so as not to leave more than twenty-two inches between each, in order to place thereon the necessary number of boxes made of pasteboard sufficiently thick or of white wood very thin. Those of pasteboard ought to be eight inches square, with borders of half an inch for one ounce of eggs; and when a larger number of eggs is to be hatched, it may be done on thin wood, more or less long and broad, with borders more or less elevated, according as desired, on which the numbers may be inscribed. They are placed then near each other leaving a space of two inches between each, and always at a height convenient to examine them easily, and so as to be able to remove them with a wooden spatule or shovel (fig. 8.): which allows opportunity to stir them without crushing them.

By means of very sensible thermometers we may easily perceive what places there may be in the hot-house where the heat is less, in order so to place the eggs as to advance or retard them as may be desired, according to the good or bad season, which may delay or not the sprouting of the leaves; placing there also some light tables on which may be deposited the boxes in which the worms are hatched. It will be very easy to place them on the tables in such manner that they may be changed from place to place at will, and according to need.

One window in large panes will give light enough, and not by excess of light produce any damage to the

worms in their first age; and if necessary to moderate the heat, a moveable board may be fixed to the window, which shall open and shut according to the degree of temperature which it is wished to have. Some have used an opening at the door, or, better still, a ventilation in the middle of the ceiling, by means of a trap, which may be arranged so as to open by raising, and close by letting it down. The hatching of the worms once completed, the hot-house may come into use for a frame house, and the worms be there disposed for feeding up to their last period, especially if it will not be again wanted to hatch others.

4th. To arrange for the hatching of the worms, it will be necessary to observe the progress of the atmospheric temperature, in reference to the sprouting of the leaves by course of vegetation; and ten days before having them out of the egg, they must be put into boxes of suitable size. After having noted it in a register fixed for this purpose, the date of their entry into the hot-house is marked, with the number of the boxes which contain them. By placing them at distances, it will be impossible for them to get mixed by crossing from one to the other. The hurdles will be covered with paper in the hot-house, which is warmed at first to 14°, and care is to be taken to keep it at that degree of heat for two successive days: the third day it may be carried up to 15°; the fourth to 16; the fifth to 17; the sixth to 18; the seventh to 19; the eighth to 20; the ninth to 21; the tenth, eleventh and twelfth to 22.

It will be easy to know by the following signs when the worms are about to be hatched. The eggs which were of an ash-grey, become more or less blue, they

then pass to violet, afterward to a yellowish grey, and finally to a dull white, though those which have been washed in a very dark-colored red wine, continue to have a reddish tint up to the moment when the worm comes forth.

Often, before putting them in the hot-house to hatch, the eggs are made to undergo the process called steeping, by enclosing them in small bags, and placing them then under pillows between mattresses, in midst of coverings of wool. From time to time they are removed and stirred,—which operation is in order to hasten the hatching of the worms. This method is rather uncertain, because it is impossible to know exactly what degree of heat the eggs may have experienced in advance, and so, to know what will be suitable to them in order to bring them out well. This should never be determined by the feeling, though it be possible so to arrive at it with certainty and confidence.

In all eggs submitted to long continued heat, the embryo that they contain acquires its degree of perfection, and the worms come to be hatched. Indeed, when, during the time between one season and the following, they have been kept in a mild temperature, there is no need of so great heat in the hot-house: they may even be hatched suddenly and spontaneously, at the time when the vegetation of the mulberry yet remains in entire repose, after being a short time in an atmosphere of 10 or 12 degrees. It is then important and essential to give them great attention; for it will be a serious loss to be obliged to let them perish for want of nourishment; and if to make them hatch a little too soon occasions great loss in the feeding of the worm,

to obtain them some days later is not so. But when once begun it will be injurious to retard the hatching, and their growth will suffer much by it.

It is not till the moment when the egg acquires a dull white color that the worm is entirely formed and ready to hatch. He will be easily discerned with a magnifying glass. Over the eggs are then placed white papers of different sizes, pierced with a multitude of holes, made before hand with an instrument. Pieces of very thin canvass may also be used; and in order to collect the worms together, they are covered with small branches of mulberry, at the end of which some young leaves are left. They are placed there, in order that the worms as they come out of the egg may climb on to the paper or canvass through the holes made in them. The branches of the mulberry serve to retain them and to prevent them from leaving the boxes in which they are hatched. The number of worms that mount on the papers is often very small on the first day. It will be best to disengage them thence, in order to attend to the great number that will come forth two days after; because the first, always more advanced by reason of their precocious birth, will disturb the order to be established in the development and care of the others. The small branches with isolated leaves should be preferred, because they hold back the small worm by their thickness, and it will be impossible for him to climb over them. They will die, for the most part, for want of ability to surmount this obstacle.

All those hatched in the manner above mentioned and by means of the hot-house, enjoy a strength and vigor which is characterized by their deep chesnut

color. They are never red, much less black. It appears to us, in viewing them placed on the sheet of perforated paper, like a woolly bed spread over their whole surface, on which are easily distinguished an infinite number of animalcules, having a high head terminated with a black shining nose. The whole length of their body is bristled with scattered hairs in parallel lines, with some larger hairs. Their skin now white is expanded as they advance in age, and the hairs are effaced and disappear by degrees. Looking at them with a magnifying-glass their white skin is seen very large at the insertion of the head. Their tail also is seen to be scattered with a great number of hairs, remarkable for their length.

At the same moment that we are occupied in hatching the worms, we must also give attention to have some vessels of water placed at convenient distances, to moisten the air about them a little; for too great dryness may injure their development, which is favored also by stirring them from time to time with the spatula. And the motion that is given them by this operation becomes more useful and even necessary as the moment approaches when they are about to be hatched. There is no loss in this preparatory attention; for when it is omitted, the inconveniences of it greatly affect the worms, during all the rest of their short existence. It will be even desirable that in those departments where persons are occupied extensively in the care of silk worms, generous councils will prevail in their assemblies to propose to government, as a means of promoting industry, to establish in each commune a local authority, expressly to have the worms hatched in common. There is no doubt that in charg-

ing an intelligent man with this duty, who is acquainted with the art of hatching the eggs, it would contribute very much to diminish the losses of whole harvests of cocons, which often occur by want of this means, or by the blind course kept up and continually adopted.

CHAP. V.

OF THE ATELIER, OR COCONERY.

1st. As too much heat accompanied with dryness in the surrounding atmosphere is hurtful to the silk-worms when they are first hatched, it is also necessary to give great attention that they be not exposed to the least cold, during 48 hours. The place where they are to live must be proportioned to the numbers which it is desired to place upon it till they shall come to the third moulting; calculating always beforehand that they will occupy a space proportioned to their growth, and how much they will require to serve them in this interior circulation without being crowded. It is known by experience that the worms newly hatched from a brood of eggs weighing an ounce will occupy a space from seven to eight feet square till the first moulting; that it must then be extended from fifteen to sixteen feet till the second, and to thirty-five till the

third. The number of boards or hurdles must be in accordance with these required measures, in order that the worms may not be crowded or heaped together. They must be placed at a distance of twenty-two inches, furnished with papers extending beyond their edges, to prevent the fall of the worms. We number the leaves of paper as well as the boxes, that no mistake may be committed by displacing them, and in order to be able to follow them to the end of their complete expansion. Two thermometers must be placed on this first frame. It is to be fixed in such way as to be able to heat it, either with a stove or with two small chimnies at the corners. The windows and doors are to be placed so as to light it sufficiently and to change the air. Its temperature must be steadily maintained at 19 degrees; always two or three less than in the hot-house, and progressively as the worm advances in age and strength. Also, when the season is bad, and when the leaves are late, the heat should be lessened: it may be brought down to 17 and even to 16 degrees, and never below.*

Mons. D'Arcet has lately made trial in France of a new mode of purifying the habitations. In his system the worms are placed in an apartment in the first story: the fire-place or calorifere is on the lower floor beneath the coconery, in a tight room, or air chamber. The air passing out of this room is conducted, by tubes placed the whole length of the floor of the habitation, and is let into it by means of circular openings, of various sizes. In the ceiling is arranged a system of tubes and of openings, corresponding exactly with the one below. Through these upper openings the air powerfully attracted by a ventilator and by a draft stove fixed in the chimney itself which receives the funnel of the calorifere, passes out, after having been introduced into the habitation, and this draft produces another in the air of the lower room, so that it establishes a continual current.

The prudent overseer, adds M. Dandolo, has done all that depends on him by putting the eggs into the hot-house when he sees the season to be favorable, and that the buds of the mulberry trees are well developed. If the season suddenly changes, as it did in 1814, it becomes then of much importance to be able, without danger, to retard the birth of the worms, and prolong for some days the two first ages. To obtain this advantage, nothing is to be done, if it is the first day that the worms have been put on the small atelier, but to lower, after 4 or 5 hours the temperature from 19 to 18, and 4 or 5 hours after to 17; and the next day to 16, if necessary. This cooling of the air diminishes the appetite of the worms gradually without danger, and by this means we delay the changes which at 19 degrees would bring them to their moulting.

The first moulting is accomplished in 5 days, at 19 degrees: it will require 6 or 7 at 16 or 17 degrees. The second moulting is accomplished in four days at 19 degrees, and it must take more than six, if the temperature is from 16 to 17 degrees. You see then how the overseer, who shall conduct with prudence in prolonging the birth of his worms and the two first moultings, will be able to gain 7 or 8 days time to guard against the intemperatures of the season. He may gain also some days in the course of other moultings, as we shall see presently. This gain of time may be, as will be seen, of very great advantage.

This plan has only once been tried, so far as known to us, and farther experiments must show its usefulness. It will, however, probably be too expensive for general adoption in this country. [Trans.]

The tables annexed to the end of his work show that in 1813 the silk worms moulted in thirty-one days; and that he made it thirty-eight in 1814, for the time necessary to ripen the leaf. I do not include in these 7 days of gain, the three days that he had caused the hatching to be delayed, perceiving that the season was very bad this last year.

Those who will not take this care, and who do not employ the means which are pointed out to prevent the contrarieties of the seasons, will be obliged to throw away their worms born too soon, or to strip too early the mulberry trees, which will in that case only afford leaves of a poor quality for the adult age.

These considerations ought to make the necessity of delaying them for some days, generally perceived, rather than to be in haste in hatching them, especially knowing that with a good method in taking care of the worms, there will be no fear of some days of warm weather, which will have no other effect but to accomplish the last moultings some days sooner. It is besides certain that the silk worms which are kept back will choose leaves suitable to their age, and particularly those that are well ripened when they are in their last age, a period decisive of the interests of the proprietor, because of the consummation of the worm's labors.

2d. Once hatched, if it is designed to raise the worms in the same place, the small branches of the mulberry spread over the whole extent of perforated paper are filled with worms in the interior of small boxes placed on the table, which may serve to transport them to the small atelier: there on other sheets of paper a little thicker those are taken bearing the number of the box, and the table placed on the edges of

the hurdles, it will be easy to take the perforated papers on which the worms are laid so as to slip them, by means of the small branches which support them, on to the paper in the hurdle. To do this more safely than with the fingers, which always injure the worms, we should be supplied with a small hook, (fig. 12,) bent, observing to place all the small branches at a suitable distance so that we may be able to cover them with leaves, as well as the spaces between them, and that the worms may be equally distributed over the whole. The space that they may thus occupy is about 20 inches square.

Pieces of thick paper must be provided, 23 inches long by 21 inches broad. Occupying them in squares of ten inches, the worms hatched from an ounce of eggs will fill four of them. This suffices till the first moulting; for their space being four times that of the small box, there will be no need to remove them at all. It is unnecessary to say that the sheets of paper must bear the number of the box that is used to cover them. We then give them a few new very tender leaves, and cut equally small, spread all about, even among the branches, in order that the worms may cover them equally; and if by chance they get heaped up in some places more than others, some whole leaves may be thrown there, which we shall take care shall cover every where where they are wanting. It is necessary to give them food, as to the first; but we ought not to give any thing to these before the leaves of paper are entirely filled, so that they may all at once receive their second meal.

As the whole mass of worms that we shall wish to have, can scarcely be brought forth in less time than

48 hours, all those that are hatched first will have some degree of growth larger than the second and third, which would seem to depend on those parts of the hot-house, where the temperature is a little different. But this difference disappears soon, on giving the mulberry leaves in greater abundance to those that are behind. They vary but little in all coming to the same size.

After what has been said, it will be readily conceived that it often requires more than three days to obtain the entire hatching of all the silk worms that we wish to get from a given quantity of eggs. Though if the moths after the temperature in which they are kept require ten or fifteen days to appear and escape from a given quantity of cocons, it is clear that the eggs cannot also be laid till the same space of ten or fifteen days; but if it is desired to give an explanation of the cause for which the eggs, put to hatch the same day, all exposed to the same degree of heat, do not give their embryo to the light all at the same time, it will be very difficult. We can ascribe it only to the particular constitution of each egg, and to the care that has been given to surround them with the proper degree of heat.

It is nevertheless true, that a raiser who has only a single small box of eggs, and whose worms may be all hatched and raised in a single chamber, need not ever to count on the first, and much less on the last births—not that they may not be as good, but to avoid their difference of age. Finally, all those who choose to trust them to strangers, and those who hatch many, should collect all those that appear in a given time; and by this means the first will not be mixed with the

last. And it will be better to lose some worms born the first day, and all the eggs not hatched on the third, rather than to be embarrassed with them during the whole progress of our cares.

As to those that must be carried far from the hot-house, a whole ounce must be placed on a single piece of paper. In a single square of 18 inches divided into four, passing the hand under the bed to which the worms are attached, and thrusting the fingers into the middle, the whole is easily separated, observing to divide them as equally as possible. For every trifling variation from all these early cares a great part of the worms will be lost, by coming out unequally and by contracting disorders of which we shall speak presently.

For the greater facility in removing to a distance all the worms hatched in the hot-house, we should be furnished with a box, (fig. 13,) in the inside of which are placed, at 2 inches distance from one another, moveable boards which may be slid on parallel grooves, and on which are placed the pieces of paper filled with worms with two handles attached on the back side. Some crotchets are fixed in a manner on the sides and back. In case these cannot be procured, a common tray may serve, but with attention not to expose them to cold: For this purpose they are covered with paper pasted thick: and the boxes containing the worms are divided by moveable boards, of 18 lines or 2 inches in thickness over the worms. We scatter over them some mulberry leaves, cut small and tender, if the removal is to be far. It must only be done, in all cases, at the pleasantest part of the day—from eleven o'clock to two or three, at latest. In the

morning, and more still in the evening, the atmospheric changes may have a very great effect on them.

As the pieces of perforated paper with which we are supplied for the worms to rise upon are of sufficient size, so that we may spread over them a large quantity of small branches of mulberry, and consequently have a larger number of worms rise at once, we may place them horizontally, and in removing them to change their place, slightly shake them. If any of the holes by this means becomes filled with the egg-shells it will do no harm, and the worm will rise through, notwithstanding. Some, to come at greater precision, note with a pencil, which is always at hand, the hour at which the worms rise all together, and when there is a considerable number, and it is desired to preserve them till the second and third day, till which it is necessary to wait for the whole to come out, they place the first in the corner of the box, and give only half the necessary quantity of food to eat.

If the embryos suffer damage by the change of heat and cold, it will be much less when the temperature is lessened two degrees than when it is increased at the same rate. As to the light, it influences them in a manner so little marked that it will be difficult to perceive it; and if in the morning, or when the sun strikes more directly on the windows, they appear to be in greater numbers, it can only be ascribed to the increase of heat that comes from it. All things equal in the preliminary dispositions for the brood, it is evident that they may all be hatched nearly at the same time. And when we send them to others to be attended till the end of their growth, we must give them, on sheets of paper large enough to hold them, an

ounce all hatched at the same time, and who must of consequence all have a like development. The division of the worms hatched the first, second and third day, will facilitate this. In the hot-house they cannot pass this term.

CHAP. VI.

OF THE DIFFERENT AGES OF THE SILK WORM.

The most important point in the management of silk worms is to know well and to establish in a permanent and invariable manner the degrees of heat and the temperature in which it is necesary to keep them, without change, during their existence. We find in the abbe Rosier the following instructions on this subject:—

It cannot be said that the silk worm dreads such or such a degree of heat, in our climate, however much that may be. Originating in Asia, it supports in its native country a heat certainly greater than it can experience in Europe. But it suffers from a sudden change from a low degree of heat to a higher. It may be said in general that a too sudden change from cold to heat and from heat to cold is injurious to it. In its own country it is not exposed to these vicissitudes.

Here, therefore, it succeeds very well, and does not require all the care that we are obliged to bestow on it in our climate. With us, on the contrary, the temperature of the atmosphere is very variable, and without the aid of art we cannot have it constant in the ateliers where we raise the worms.

A long series of experiments has proved that in France the 16th degree of heat, indicated by the thermometers of Reaumur,* is the most suitable to the silk worm. Some raisers have carried it up to 18 and even to twenty degrees, and the worms have succeeded equally well. We must never lose sight of the fact that the silk worm fears not heat, but too sudden change from one condition to the other. Thus, in making him pass in a single day from the 16th to the 20th degree, he will experience a malady very hurtful to his constitution. If it so happen that we are obliged to hasten the growth of the worm, on account of the leaf whose vegetation we cannot arrest, it must be done little by little, and so as to be scarcely perceptible to them; for the silk worms suffer, so to speak, as much by the changes of temperature, as by the difficulty of breathing when immersed in a noxious air.

M. Boissier de Sauvages relates, that being pressed by the sprouting of the leaves, already well started in the first days of April, he gave to his worms about 30 degrees of heat in the two first days after they were hatched, and about 28 during the remainder of the first and second age. There were but nine days from the birth to the second moulting, inclusive. All

* The degree of heat is always by Reaumur, in this volume.

who saw them had not imagined that the silk worms could resist a heat, that in the space of a few minutes made themselves sweat in large drops. The walls, the edges of the hurdles were so warm that the hand could not bear it. All of them must die, they were sure. However, it all came to the best, and to their great astonishment the crop was abundant.

He gave afterward 27 to 28 degrees of heat in the first age, 25 or 26 to the second, and, what was singular, the durations of the first ages of these broods was nearly equal to the preceding, in which the worms had more heat; because perhaps there is a limit beyond which the life of insects cannot be shortened, whatever heat they experience. It is true the worms of this brood had had the same number of meals as in the usual treatment. But what is still more singular is, that the worms thus hastened required but five days to each of the two next moultings, although they were in a temperature of only 22 degrees, while worms which at the commencement have not been pushed forward in this way, take, in a like degree of heat, seven or eight days to each of these same ages, that is, the third and fourth. It seems to be sufficient to have set these little animals going on their course, in order to have them follow of themselves the first impulse given, or the first habit they have been made to take.

This method of which he speaks, which works a rapid growth, gives at the same time to the insects a vigor and activity that they retain in the following ages; which is an advantage in the quickened treatment, (that is to say, pushed forward by heat,) and which besides prevents many maladies. This hasten-

ing method abridges care and labor, and releases the superintendent sooner from the anxieties which, if he has only in a trifling degree a wish to succeed, scarcely quit him until he has gathered his crop of cocons.

To follow this method it will be fit to give great attention to the more or less advanced state of the season, to the sprouting of the leaf, if it is not afterward arrested by frost. On the other side, if the leaves appear late, and this is followed by heat which continues long, as commonly ought to attend it, and meanwhile but little fire is made in the atelier, they advance slowly and prolong their youth. Meanwhile the leaf grows and hardens; it has too much consistence for them, it is time to hasten them by a quick and warm treatment, in order that their progress following that of the leaf, should not be different from it, which is an essential point.

If the raisers fortunately decide for this method, they have them warmed and hatched some days later than the others. More wisely still they wait eight days and calculate thence the duration of the ages, or rather they do yet better to wait and make their arrangements, so that the end of the feeding of the worm may correspond with the time when the leaf has come to its last degree of increase.

It has been said above that the worms produced by one ounce of eggs at one hatching, must occupy in the first age, and till the first moulting, a space of 7 to 8 feet square, of fourteen to fifteen in their second age, and of 30 to 35 in their third: in the fourth and last it must be at least 83 or 84. We must then make the quantity of food given them proportioned to the space, not forgetting that up to the first moulting, we

must constantly keep them in a temperature of 19 degrees: in the second age it may descend to 18; in the third to 17; and to sixteen in the fourth. These degrees of heat well fixed in mind, we shall then give them immediately after their birth, their arrangement and distribution on the papers, six pounds of young mulberry leaves cleansed and cut or hashed very small. In the second age it must be increased to eighteen pounds, but now less cut up; in the third we may go up to sixty pounds of leaves yet less cut; in the fourth we shall give them one hundred and eighty pounds cut only in half.

However, some unforeseen circumstances may occur that it will be difficult to calculate on beforehand. But with attention and foresight a person will be able to hatch the worms at the moment when the trees shall present their tender leaves, which should acquire a considerable firmness, in proportion as the worms have attained a more advanced growth; otherwise, it will be necessary to abandon them, and suffer them to perish, relying on getting a new supply, when an unfavorable season retards the sprouting of the leaves; although, if they have been made to hatch when the season is favorable, but which from unforeseen circumstances has become bad, it is more easy to retard their growth, at least for some time, and to keep them back until there would be no more to fear in seeing them developed as fast as is natural to them, their growth being in accordance with that of the leaves. In the case where the leaf has not the requisite qualities, we may also diminish or increase it according to circumstances; for all the quantities which have been determined by approximation, though confirmed by repeated

experiments, depend almost entirely on the temperature in which the worms have been nourished. In fine, the prescribed economy does not, in parallel cases, by any means forbid them to devour in some sort, with good appetite, as much as they may digest easily, and as will preserve them constantly in a vigorous condition, as good as it is remarkable.

To economize the leaf, and obtain a crop as abundant as possible, should be the principal aim which all who would engage in raising the silk worm must have in view. It is known, by experience, that by overfeeding them, we not only lose the third, and sometimes more; but that by the accumulation of their litter, the little vigor which they enjoy during some periods of their existence undergoes changes in the time of their moulting, which, from an appetite very marked, makes them pass to a state of languor so visible, that if the cares and attentions are not redoubled, the worms become feeble, languishing, sick, and before long die. But if, on the contrary, we neglect nothing in the attentions to be observed,—if we follow to the letter all the rules laid down for the best development of the worms, we shall harvest a quantity of cocons proportioned to the eggs brooded, and to the mulberry leaves consumed. For M. Dandolo assures us, 1st, that to obtain 110 or 120 lbs. of cocons from one ounce of eggs, there need not be used more than 1650 lbs. of leaves.—2d. that to obtain from an ounce of eggs but 55 or 60 lbs. of cocons he has employed nearly 1050 lbs. of leaves; at which rate nearly 2100 lbs. of leaves would be necessary to obtain 110, or 120 lbs. of cocons.—3d. that the 110 or 120 lbs. of cocons obtained by one ounce of eggs are worth much

more than the same quantity obtained by two ounces of eggs.

In fine, if, as M. Dandolo assures us, we may with an ounce of eggs, hatched and well attended, obtain nearly one hundred and sixty-five pounds of cocons, all that we receive short of this in a crop, must be considered as a real loss, although the consumption of leaves have been much more considerable; and if we add to this the effect of the worms that have died, in the course of their development, or those that have survived, we should agree that they are in such a state of indisposition and feebleness, that it will be impossible to obtain any profit from them. For the more their number is diminished for want of care, the less silk of good quality is supplied by those that remain. It is desirable in this case, in order to remove all doubts, that it were possible to establish a comparison of the quality and quantity of cocons that proceed from the good method of taking care of the worms, and the bad one, which almost always results from custom and prejudice as much as from negligence. A series of approximate tables, in a course of years, with the meteorological indications of the atmosphere during the season, will be the best means to employ to ascertain all the losses caused by the ignorance from which the overseers will not depart, whatever efforts are made to draw them from it.

I. THE FIRST AGE.

Scarcely are the worms hatched and distributed on the squares of paper, when it will be necessary to give them, on the first day, food four times in succes-

sion. For this, some tender leaves are to be cut very small, with a knife, or other sharp instrument, (fig. 14, 15, 16,) which must be distributed to them moderately at the first meal—increasing them at the second, third, and fourth, at a distance of six hours or less, from one to another. The worm takes but an hour and a half, or two hours at most, to satisfy himself, and falls then into a sort of torpor, during which it is necessary to watch him, and to keep him in a temperature constantly equal, avoiding the alternatives of heat and cold. For five ounces of eggs we must place leaves to the worms on a space of thirty-six feet eight inches square, and distribute to them nearly four pounds of young mulberry leaves, tender and moreover cut up; while for one ounce of eggs hatched, we must give a pound and a half. Twenty inches square also is sufficient to contain them, so that the leaves may be every where eaten; and as the worms do not yet throw out any excremental matter, it is useless to change their place. Besides, they are so frail and delicate, it is not possible to touch them with the hands. Finally, if some lose their way, they may be lifted adroitly with a birch twig or a needle, to put them in place, as well as to gather up the leaves which fall a little too far from the worms during the distribution. We must have care, after the distribution is finished, to collect them up with a small broom; but, as has been observed, the worm at this period consumes in the space of twenty-four hours a quantity of leaves equal to his own weight, they must never be given to him all at once: we must, on the contrary, reserve a certain quantity of them to give them at intervals more or less distant, and principally in all

places where they seem to fail of it, because scantily distributed.

On the second day, we must use in twenty-four hours six to seven pounds of fresh leaves, selected, picked and cut very small, observing to distribute a less quantity of them the first time, and to give them all that remains at the last distribution. We extend, we enlarge, little by little, the squares. Already the aspect of the worm is no longer the same, as the day before: his head is larger, and more white; the color of his body fades; his hairs are less apparent.

On the third day, as the worms during this day eat very greedily—as they occupy already nearly two thirds of the sheets of paper, we shall give them three pounds of chopped leaves at each meal, and, in order best to satisfy them the first time, we give them half; and if it was consumed in one hour, we hasten the time of the second distribution. In the middle of an interval to the other we shall give them a half, though they may not be entirely recovered. Their particular disposition, and the quantity of leaves cut to distribute to them may serve for guides in the case mentioned. Their head toward the end of this day is whiter: they have grown to a much greater size; the hairs have nearly disappeared; the skin has become reddish; their body, and particularly the head, has become shining, with a semi-transparence.

On the fourth day, as the appetite of the worm diminishes, we must also diminish the quantity of food. We should use then only seven pounds of cut leaves. The first distribution should be of two pounds and a quarter, and the others will go on diminishing as the leaves seem to be untouched. The superintendent

will also use caution in the subdivision of the intermediate distributions. The leaves will fill them completely. In their expansion at each meal, he will prevent their touching one another, which will be hurtful to them. As in the first part of this day many of the worms will move their heads, it is a sign that their skin troubles and burdens them. A great number eat but little. Their head has become enlarged: it is more shining in the evening. They are nearly all torpid, and do not eat: their body is almost transparent; they approach their moulting; and if we observe them closely through the light, we find them a white mass, livid and yellowish.

For the fifth day.—In the course of this day, a pound and a half, two pounds at most, of fresh leaves cut up, are sufficient. They must be distributed as equally as possible through the day, and only in the places where we perceive the worms ready to eat them. If the quantity indicated is not sufficient, it may be increased, as it may also be diminished if this becomes necessary. Too much attention cannot be given to the exactness of the distribution, as well as to the economy of the leaves. Toward evening the worms are nearly all drowsy; some just begin to awaken.

The first moulting ended, the worm takes an ash color. His wormlike motion is very apparent: all his folds move back and forth on one another very free and easy. The leaf that he is to be fed with should be plucked at least eight hours before it is given to him. It may even be kept a day or two, in a cool and dry place, sheltered from the heat and light.

Thus the first age of the worm is ordinarily complete

on the fifth day, not reckoning the two days to collect and arrange them, while they are hatching. At this time they have consumed little more than thirty pounds of leaves. They have increased to fourteen times their weight, in the space of six days, and are lengthened to four or five lines, when, on coming from the egg, they are hardly one line * long.

We recommend, moreover, to renew the air from time to time, which serves for their breathing in the small atelier, either by opening the door or window, if the season be pleasant: in the contrary case it may be warmed with stoves or chimneys, if there is any, to maintain the proper degree of heat equal and constant, in order that they may be kept sound, vigorous and in good health. It is also, in some sort, in this first period of their existence, that depend all the other circumstances that attend their condition to the end of life.

II. SECOND AGE.

Thus, on coming to their second age, the worms from five ounces of eggs will then occupy a space on the boards of seventy-three feet nearly, and all covered with paper. The temperature in which they are kept must be from 18 to 19 degrees. To change their litter, we must wait till they are in great part awake; and if they go from the leaves where they have been placed, they must be changed immediately. In fine, their inequality is because they have not been arranged in a manner suitable to their development—that many have eaten constantly, while some have remain-

* Twelve lines to an inch.

ed under their litter, and all the others above, at the same time breathing an air where they are suffocated under the leaves, where they were torpid when they should be awake; or finally, because of the alternatives of drowsiness or animation, in which they have been obliged to pass, by the negligence of those who should have watched them. We also ascribe their inequality to this, that those last hatched have been placed in the least warm part of the atelier on the first day after being hatched, while they should have been placed in the warmest part. If the growth, lastly, is not accelerated by additional distributions of food, to make them come on as fast as the others, it follows that in the period from the first to the second moulting, they continue in a state of drowsiness, while the others are awake and feeding; and that the slow ones eat only because they have not come to the time for sleeping. Thus it is very common to meet them of four different sizes on the same leaf, as also to see the latest born die. And it is on coming from their moulting chiefly that they experience great need of air, and of a pleasant and equal warmth, to hasten the strength and energy of their organs, which will be of the greatest utility in causing their growth, were it not that by the scaly snout that they lose by the moulting, and which is replaced by another, whose tenuity tends continually to be hardened by contact with the surrounding air.

On the first day of the second age, it will be necessary to provide nearly nine or ten pounds of small branches of the mulberry, as tender as possible, and as many of fresh leaves cut small after being washed and culled. We must also make all preparations for

changing them, removing them in order to cleanse the first leaves of paper on which they were deposited. When we perceive they have well waked up, that they move their head, and hold it raised, and to the right, as if seeking something, and there are a considerable number that have removed themselves from their litter, we begin with those where the greatest movement is observed—we place across some small branches with their leaves which are placed at equal distances, and as quickly as possible. Immediately they are covered in every part with worms which attach themselves. Then, by means of some small transport tables, smooth and even, (fig. 9,) we change the small mulberry branches that are covered, and instead of the squares we make sections that are extended in the middle of the tables disposed in such manner that we have nothing more but to enlarge them on two sides when there is need; for then the worms should occupy only the half of the space that is destined for them.

By means of these small tables, which rest only in their length on the hurdles or boards, we make the small branches fall softly by inclining them, to range them suitably with the hands, and dispose them in order. Moreover, when we find on the litter a considerable number of worms awake, we place also some small branches to collect them, and place them as the preceding on the scattered leaves which may be counted as a distribution to them; for, in a short time after this new arrangement, none of it remains. So the contact of the warm air is sufficient to develope their jaws, enfeebled by the moulting; and, far from preferring to rest on the litter where they have before, they are seen to group on the small branches which

have served to transport them, so tenaciously that they remain there as in heaps; also to change them at all times, and in every period, this method above mentioned is the preferable one, and the best to follow.

One or two hours after the worms have been changed and placed on the boards, we must distribute to them three pounds of leaves, cut small as before. In case where the worms, heaped up on the small branches that are stripped of their leaves, leave large spaces between each, other leaves must be distributed to them, in order that they may spread themselves out and enlarge the space that they occupy after this first repast. The two other meals for this day must be distributed at six hours interval each. The removal of the worms being accomplished on the other boards, we roll up the pieces of paper that they occupied, one on another, to carry them out of the frame. For what remains is only excremental matter, mixed with fragments of leaves which have been administered to them since their birth. In thirty pounds of leaves we count that there is twenty-two and a half of it completely digested.

On the second day, the seventh after their birth, we distribute to them thirty pounds of leaves, cut up, giving them in four times at six hours interval. The two last distributions may be a little larger than the first. We shall enlarge the sections in the evening, so that they may be two thirds completely occupied. The worm, in his whole length, becomes a clear white. His head is a little larger. We lay them out, as has been said, taking them on the small branches to put them on the places where there are but few. For it is extremely important that they be equally divided.

On the third day, the eighth from the egg, the two first distributions should be the greatest. Thirty-three pounds of leaves, cut small, must be used in the day; taking care, moreover, to apportion them according to the want of the worms. For toward the close of the day not only their appetite diminishes, but they lift their heads high, they eat no more, and fall into a very marked drowsiness. We must enlarge their space so that they occupy four-fifths of it.

On the fourth day, the ninth, we should only distribute to them nine pounds of leaves, cleansed and cut up, observing always to scatter them equally and lightly. Once that they are completely asleep, they do not wake till the next day after their moulting. In calculating their consumption of ninety pounds of leaves, cut up, and of small branches, with what remains of the litter, it is demonstrated that twenty-one pounds is necessary to feed each ounce of worms separately.

During this second period they become of a grey color. Their small hairs shortened are almost imperceptible; their snout which was black has whitened, and is softened to its present form and color. It hardens again, in proportion to its progress, and by reason of the need that it must have of more solid aliment. On its back we perceive two lines curved opposite to one another. He is lengthened two lines: already he has need of a greater quantity of air to breathe: his respiration singularly increased, requires to be often renewed, either by opening the windows when the external air is mild, or in opening the door, or any small opening that is practicable, and until the thermometer descends one degree.

III. THIRD AGE.

On the first day, the tenth from their birth, the provision must consist of fifteen pounds of fresh leaves, cleansed and less cut up than for the preceding, to which must be joined as much of the small branches. The worms of five ounces of eggs will occupy 174 feet, which we must take care to cover with paper. They must be kept in a temperature of 17 to 18 degrees. They are not to be changed till nearly all are perceived to leave their state of torpor, which is ordinarily in 24 or 30 hours at most, and is shown by a movement of the head in a rotary direction. And the wind cannot hurt them, though in blowing over them they appear to experience something disagreeable. In changing them after this moulting, the same precautions must be taken as in the preceding. If the space to be occupied by the worms in their different ages is taken into calculation, it is not an easy matter to know how to raise them, to clean and dispose them on the hurdles, where they are left till they have finished their moulting, at proper distances one from another. They eat with the greatest facility. Their litter is not altered in any manner. Their first distribution will consist in the five pounds of small branches filled with leaves, which, when they are eaten, must be replaced by seven or eight pounds of other leaves equally distributed by means of the broom. The point most essential is then for the person charged with the raising and care of the worms, to make an equal division of them on the boards or hurdles, as well as to observe a just distribution of leaves with which they are fed; for it is a

clear loss for them to consume too much food, and the surplus will only serve to augment the litter, which will bring an inevitable fermentation, and may be the cause occasionally of many morbid affections. We finish this day by a distribution of seven pounds of leaves. Indeed, if not possible to make it, they may be preserved to add to those of the next day.

A very little promptness given to them will enable us, in an hour or two at most, to change worms enough to cover 174 feet of boards or hurdles. As soon as possible after the change of the worms the litter must be rolled up with the paper, and removed away. Before clearing them of it, we must look that no torpid worms remain, whom the contact of air will reanimate more quickly than that of the atelier, and after having placed them on the small branches, we must put them with the others. As to those last taken up, we must keep them on separate boards, in the warmest parts of the atelier, and well scattered.

Dating from this time, their consumption is very great. To feed them easily, recourse may be had to square paniers, (fig. 19,) which may be hung around with the aid of a hook, and thence may the leaves be drawn with both hands, and distributed at will, either to the height of the individual or on the highest boards, by means of small steps or ladders very light. Before they have finished eating three or four of these distributions, it will be perceived they have sensibly increased, that their color is clear, and also that their nose is elongated.

On the second day, the eleventh from their birth, we must be provided with ninety pounds of leaves cut, the two first distributions of which shall be less

than the two last, because that in the evening the worms increase in appetite. We must increase also a little the space that they occupy.

On the third day, the twelfth from their birth, we give them seven pounds of cut leaves more than the day before, observing to distribute them in much the larger quantities at the two first meals. For the distributions of the evening ought to be less, because they lose their appetite, and they increase very much. They whiten, become transparent; their head is lengthened; the movements which they make with it precede the moment when they are about to fall into drowsiness.

On the fourth day, which is the thirteenth from their birth, the provision will be only fifty-two pounds of leaves, because the appetite of the worms is much less. The largest number is already torpid. The distribution at the first meal should be the most abundant, and the last much less. We do not even spread the leaves but in the places where they fall, which want makes them perceive. In cases where most of them become torpid, and that some are found on the same board who still want to eat, we need not fear to give them something, in order that they may overtake the others. We always obtain excellent effects from these intermediate repasts.

On the fifth day, the fourteenth from their birth, the distribution of the cut leaves should not be but twenty-seven pounds for the whole day, scattered in all places where the want of them is perceived; since the day before this we find every where the froth and the silk which the worms have thrown out. We see them seeking to go to sleep in free currents of air,

in dry places, holding their heads continually raised; and those that are obliged to remain on the litter raise themselves above, keeping the same position. At the instant when they pass into the state of momentary torpor, they evacuate all that they have within. The intestinal canal is distended by a lymphatic fluid, yellowish and transparent. The epidermis becomes wrinkled and dry before it is separated. Through the whole time of their moulting the air of the atelier must be fanned and renewed, all of it retaining the temperature to the same height that it had before.

On the sixth day, the fifteenth from their birth, the largest part of the worms is disposed to go into the state of torpor; their third age is finished; they have passed it over in the space of six days, consuming three hundred pounds of leaves and small branches, which gives nearly sixty-nine pounds to the ounce of eggs. Their nose is lengthened, jutting out; from black, which it was before, it becomes red, greyish. Their head, their body have sensibly increased. Their body marked with wrinkles, as well as the head become smooth. We no longer see any hairiness. Their general color draws near to the orange yellow. All their feet toward their posterior extremity spread, enable them to adhere strongly to what they touch in feeding. We hear also a slight noise, which they make in moving from place to place, which ceases when they become fixed, and becomes more strong as they advance in age. Since the second moulting they have increased in length six lines, and have increased to four times their weight.

The space that the worms must occupy is 412 feet square, and the temperature in which they must be kept, may be raised from 16 to 17 degrees; and though it should rise to 18, or even above, we need have no anxiety, provided the internal air be renewed from time to time by the opening of doors or windows. By this means we prevent the litter, which is mostly moist, from undergoing fermentation, and throwing out exhalations that would be hurtful to the worms. Many times whole broods have perished for want of these precautions.

The hurdles are not to be changed till after we have seen nearly all of them revive from their torpor. Those first awake should be put in the least warm places, and the last in those which are of the highest temperature. By means of a thermometer it will be easy to ascertain them. These attentions are indispensable when we wish to have them all mount together. Thus, the third moulting of the worms once finished, we must bring them into the large atelier, not to be again removed, where there must be, in order that they may be at ease, 920 feet of surface, either in one large room or in two or three small ones, but contiguous and adjoining, for the greater promptness and facility in the service. Meantime, as on leaving their third age they occupy but 459 feet, it must be marked out beforehand, and they must be arranged by sections, which may be enlarged at will and gradually. It results from this arrangement, essential in all broods of worms, 1st. that the litter which it is not necessary to take away in the fourth

age, increases but imperceptibly, and as it is not very thick, does not disengage any very strong odor. 2d. by the distributions of the leaves, placed at proper distances, it results that they are very equally consumed; they have not then time to decay, and yet less to be tainted. 3d. that the worms conveniently scattered eat much better and at their ease. It is much more easy also to move them, and the perspiration as well as the respiration is performed in a manner very advantageous to them.

For the first day, which is the sixteenth of their existence, we must prepare thirty-eight pounds of small branches and sixty pounds of leaves, cut in two or three, with the instrument. (fig. 16.) When it is necessary to change the worms, we spread some of the small branches of mulberry on two hurdles only at first, and when they are full and covered, we remove them by means of the tables. It is very easy to supply the small branches with leaves, by tying them together in greater or less numbers by their petioles, (stems,) in order to lay them out and to lift them away all at once when filled with worms. This change is soon made by only two persons having charge of the worms, and two others to remove them as quick as possible to the place destined for them. If some remain who are still torpid, they are to be collected together in a separate place. We distribute then to the whole mass thirty pounds of leaves, the whole length of the company, which we must preserve every where of the same breadth, taking up the scattered leaves by means of the small broom. Soon all are equally disposed over the hurdles; and if the leaf is yet cut for three or four days, it makes them eat a little

quicker, for the reason that it exhales more odor, and that it presents to them a greater number of edges. The second distribution being over toward evening, when it is entirely consumed the worm grows white, acquires strength and vigor, his motions are much more marked.

For the second day, which is the seventeenth of their existence, we use 165 pounds of leaves, coarsely cut. We give them moderately of them, the three first times, and largely at the fourth distribution, enlarging by degrees the space they occupy, because they increase very much in size. They acquire at the same time a color much whiter.

For the third day, the eighteenth of their existence, we shall give them in four meals 225 pounds of leaves, cleansed and coarsely cut; observing also that the two last distributions must be much larger than the two first.

For the fourth day, or the nineteenth from their birth, two hundred and fifty-five pounds of leaves will be used. The three first distributions must be made so that there may be consumed nearly seventy-five pounds at each time, and forty-five at the last. Toward the end of the day, the worm attains to the length of 18 lines. He is then much whiter than he was the day before.

For the fifth day, or the twentieth of their existence, as the appetite of the worm is sensibly diminished, we shall use only one hundred and twenty pounds of leaves, coarsely cut. The first distribution is to be the most considerable. They nearly all fall into torpor and drowsiness. The other distributions are only to be made in the places where some worms

remain not torpid. Generally they have increased two lines more.

For the sixth day, the twenty-first of their existence, thirty-five pounds of leaves will be quite enough for their nourishment, scattered and distributed only where the want of them is apparent. Since yesterday they have evacuated, they are become much smaller, the green color is effaced; the skin is scattered with wrinkles scarce visible.

On the seventh day, the twenty-second of their existence, they accomplish their fourth moulting, and awake from their drowsiness. During these last seven days they have lengthened six lines, have become of a color greyish and rather brown, with an increase of weight very perceptible. During the whole of this age it is absolutely necessary that the air of the atelier should be preserved in a state of continual purity. It must also be changed as often as appears necessary, by the opening of doors, of windows, vents and ventilators, whenever the external temperature is nearly like that of the atelier; and in the contrary case, by making some fire in the chimney with dry combustibles. A state of purity in the air in which the worms are constantly immersed, is of the first necessity to preserve their existence in a condition of sustained vigor, and to prevent them from contracting maladies. All persons also occupied in taking care of them ought to have no disagreeable sensations in respiring the air of the atelier; and when they feel the least pain or disagreeable sensation in the action of the bowels, they must immediately use all the means at hand to renew the air about them.

V. FIFTH AGE.

On the first day, which is the twenty-third from the birth of the silk worm, the fourth moulting is finished, and nearly all are revived from their drowsiness. They must be kept in a temperature of 16 to 17°. Spread over 918 feet of boards by a sufficient number of persons, their work must be finished in eight hours at most. The first distribution will amount to ninety pounds of small branches or of whole leaves, and as much at the others, having been first cleansed. The branches will be scattered on four or five hurdles. Once filled with the worms, we remove them on to the others, in the middle of which is left a space larger than half. We proceed then to the cleansing of those that are vacant, and all those remaining torpid are collected together, as we have said above, on separate boards, to be exposed to the warmest place of the atelier, and so nursed that they may arrive as soon and at the same time as the others, at the appointed time for mounting.

If good care has been given in the first placing of the worms on half of the boards, if the vacant space has been well preserved in the middle, in two times, all the worms will be equally scattered in the whole interior of the atelier, and in a suitable manner; the leaves which were on the branches used have served for one of their repasts. What remains of the leaves and of other branches, will be distributed to them at six hours interval, sweeping together with the small broom all that shall be scattered from the line, and dispersing the worms where too much heaped up, to the places where there are less. At the last meal,

which will only be of forty-five pounds of leaves, the sections are to be again enlarged. All appear then to enjoy a vigor well marked. We should give them some air, by opening the windows, if the external temperature is nearly the same as that of the atelier, especially while we are cleansing them; and if we pay a little regard to the situation of the hygrometer and thermometer, it will not be difficult to know what changes can be made in the temperature of the air surrounding them.

On the second day, the twenty-fourth from their birth, we shall distribute to the worms, continually enlarging their sections, two hundred and seventy pounds of clean leaves, which they will take in the following manner, to wit: fifty-two pounds at the first time, and ninety-seven pounds at the last. It will be very apparent that toward the close of the day, they are still much whiter than they were the day before, and that they tend continually to expand themselves.

On the third day, the twenty-fifth from their birth, we shall distribute to the worms, who from this time consume much more, the quantity of four hundred and twenty pounds of clean leaves. The first time, we shall give them seventy-seven pounds, the second and third, a little more than a hundred pounds, and finally, the fourth a hundred and twenty pounds. Indeed, they may eat much more, but the quantity here indicated has always appeared to be sufficient to preserve them vigorous, when attention also is added to enlarge the sections, in proportion as the leaves are given to them, because they attain to twenty-six and twenty-eight lines in length. Their whiteness increases also very much.

On the fourth day, the twenty-sixth from their birth, the quantity of leaves to be distributed to them, must be still further increased. We should give them at the first distribution one hundred and twenty pounds; at the two following one hundred and thirty-five, and at the last, even one hundred and fifty, because they increase in appetite, and because having attained in a short time to the length of about three inches, they need much more. We need not fear, at this time, to give them five hundred and forty pounds of leaves.

On the fifth day, the twenty-seventh from their birth, the provision must be increased to eight hundred and ten pounds, of which the first distribution shall be one hundred and fifty pounds, the last two hundred and ten pounds, and the two intermediate two hundred and twenty, and two hundred and thirty. It is also very often of indispensable necessity to make some partial distributions in the intervals between the chief meals, especially in places where we perceive the worms may have been a long time fasting. If we wish to clean the hurdles, it must be done at the close of the day, or early the next day, distributing the leaf on four hurdles at a time. But as we do not again change the worms, as we do not again remove them from the place they occupy, we take it in the manner following. A short time after the leaf has been distributed, and that it is covered with worms, we place them as quick as possible on the small tables, supported on the edge of the hurdles: we take away immediately the litter, which is thrown into baskets similar to those in which the leaf is put for distribution. The work finished, we replace the worms as they were before, and so on to the end.

With whatever quickness the change of litter is done, it is always quite long enough. We must then feed the first, in order not to leave any interval, and that the meals shall be equally distributed between the last and the others. We must preserve also the interior of the atelier, under the same relative moisture, under the same atmospheric warmth, and the same air that it contains, to the end that all may be in a state suitable to preserve the worms in the vigorous condition acquired in the progress of their age. It is unnecessary to say, that the litter collected in the baskets must be carried out, and that in the handling made necessary, for the change of the leaves that are covered, good care must be had, of the manner of taking them up, so that the worms may not be injured by the fingers.

On the sixth day, the twenty-eighth after their birth, if one has not witnessed the voracity with which the silk-worm throws himself on all the leaves that are given him, we cannot give him a just idea of it. He attaches himself even to the berries, that by chance come in his way. On this day, we shall distribute to them, in four meals, nine hundred and seventy-five pounds of leaves. The last distribution will be, as much as possible, larger than the others. We ought not, also, to forget to add some in all the places where the worms seem to have need of it, in the intervals of the repast; for the saws, with which the worm tears what is given him, have become of a great length. He has attained to three inches in length; and if he is very white, soft to the touch, and of a velvet smoothness, he may be considered in a state of perfect health.

On the seventh day, the twenty-ninth after their birth, is the day when they come to the greatest length that they acquire, and to the fulness of their weight. It is often the case, that six of them weigh an ounce. This is the moment of their greatest vigor. We shall give to them, in larger quantity at the first time than the others, nearly nine hundred pounds of leaves, diminishing them successively to the fourth, always adding the intermediate distributions, if they are made necessary by circumstances. Toward evening, their extremity, from white, which it was, takes a yellowish color. We say *that they ripen.* Their mastication sensibly diminishes. It is the same with their weight, and with their length. They throw out a large quantity of excremental matter; they are in a constant exhalation, and vaporization; and if in about seven days they have doubled in length, they come soon to decrease in the same manner.

On the eighth day, the thirtieth from their birth, they have only need of six hundred and sixty pounds of leaves. We should choose the best possible, and those taken from old trees; for the appetite diminishes much. The first distribution will be the greatest. We give them, at this time, two hundred pounds, and go on diminishing to the fourth; and that they may ripen nearly at the same instant, we make, as before, some intermediate distributions, wherever the need of it is apparent. Their yellow color deepens by rings over rings; they become shining, are no longer greenish, diminish sensibly in bulk; they seek the edge of the hurdles, to evacuate what they ought to throw off; then, as soon as it is perceived, that they have come to maturity, and especially if the moisture

is too great, we change the litter with the greatest possible quickness; we watch the state of the atmosphere in which they are immersed, the air which surrounds them, and we remove all those circumstances that may become hurtful to them, in one way or another.

On the ninth day, the thirty-first from their birth, the provision of leaves will be only four hundred and ninety-five pounds, to distribute everywhere, and as there shall be need. The worms become more and more yellow, the surface of the back is more shining, the rings are orange color, the nose transparent. We must avoid currents of air, and sudden changes of temperature, although it may be proved, that some vigorous and very healthy worms do not experience any remarkable inconvenience, when even they are exposed to the various inclemencies of the seasons.

Thus, the silk worms, from their birth to this time, have become nearly forty times as large as they were, and in the space of a month, they have become nine thousand times heavier than they were when hatched. The most active period of their transient life, is the space of the fifth age, which is nine days. Finally, to arrive at perfect maturity, there is yet need of great watchfulness. It is so even in laying aside the skin which covers them, that they may become chrysalis, losing at the same time half of their weight and bulk. The black transverse lines reappear on their back, and the scaly prolongation of the nose becomes blackish, and shining, and very hard. Their whiteness is much more perfect than it has yet been. If we touch them, we find them fleshy and like velvet, especially if they are vigorous and healthy. It is also

the time, not only to keep them in a high state of temperature, but also to renew the air as often as necessary, were it only to favor the operation of the perspiration that exudes continually from them, in these last moments of their life.

In the last period of the fifth age, in order to the formation, and complete perfection of the cocon by the continual shedding of silk, even to the moment when the worm becomes a chrysalis, it is necessary that the silk worm should come to be composed only of two substances—one silky, and the other purely animal, and that he shall have evacuated all excremental matter contained in the whole length of the intestine; which keeps them, so to speak, in a state of complete property;* to administer to them at the same time more of the leaf, not only to fill up this day, but also to await, sometimes, twenty-four hours longer, their complete maturity. It is known by the following signs. On the tenth day, the thirty-second from their birth, if we give them fresh leaves, if they rise up, if they do not eat, if they hold their neck extended, their head elevated as if they were seeking something, if they are transparent and of a handsome yellow, when they rise on the hurdles where they have been supported, mounting slowly, and when they come to the edge of it, seeking to go farther, when their rings disappear, and their greenish color is wholly changed to an orange yellow—then some wrinkles appear on the neck, and the whole body becomes flabby: in fine, when placing one of the worms in the hollow of the hand, we view it in the direction of

* That is, animal and silky matter exclusively. [Trans.]

the light, and perceive that everywhere it is traversed with luminous rays, we must immediately arrange every thing convenient to favor the mounting, for fear lest the searches they may make, by exhausting them, will cause them to lose their silk.

From this moment, we must occupy ourselves in preparing all things that may be necessary for the mounting. For this purpose, we collect a sufficient quantity of dog-grass, small chosen branches of young oak, straw of rape-seed, broom gone to seed, and especially heath. These are preferable to all the others, especially in the second year they are employed to this use. But we must have the precaution to pass them over a clear flame, which we may easily obtain with those that we would throw away, in order to burn the small ends, and destroy the foam with which they are impregnated the first time that they are used. Striking it on a block or large stone, we easily deprive the whole mass of the small ends, with their leaves, making it into bundles, which we roll together, in order to use the following year. For the rest, whatever may be chosen for the abode of the worms, we must always take fresh young branches of green flexible plants, pruning off the most slender extremities which may be too weak. Finally, all bushes from which we have stripped the leaves, and taken off their last small branches will be very convenient, made into fascicules or small fagots, like a broom. We must also take care, in forming them, as well the thin, as the thicker, to place them one by the side of the other, with an interval of twelve or fifteen inches at most, supporting them at the lower part by the side, where they are attached to the hurdles, and at the top

by the lower part of that which may serve for a ceiling, and at the same time, sustain them separated in the form of successive arches. All the interior of the boards thus filled, represent sufficiently well, small vaults, to which, after this particular disposition, the worm feeders have given the name of cabins.

The small branches, which we take by the handful, must be arranged so that, touching the under part of the hurdle, which serves it for covering and ceiling, they may form a sort of arch; the base of which commences on that on which they are fixed. They are to be disposed, so that the worms which rise may not fall. The small branches, a little longer than the distance between the two hurdles, will allow of their being bent in such manner that the worms that have climbed may not foul, by the excrement they throw out, those that follow, which must happen for want of all the precautions mentioned. They should be fan shaped, in order that the air may circulate well through the boughs, and that the worm may not be at all constrained in the labor of the cocon, and especially that he may not make his cocons double, which always occasions loss in the product. If we use hurdles, we set up the fagots between the rushes. In case we use boards, it will be enough to place them on their ends, in order to make them keep erect. Finally, if on this day we perceive that they seek to rise, we carry them to the foot of the branches, either by the hands, or by placing at distances other small dry branches on the litter; and when they are fixed to them we remove them to the place where they are to remain till the end. However, it is better to await their motions, than to hasten them. Finally, for the last repast, we

should observe again if they have any wish to eat, and distribute to them the few leaves that remain, but with caution; for, by emptying themselves, this will only increase the litter, that must be cleaned again at least twice. For this, we wholly separate the worms, collecting them with the greatest attention not to press them with the fingers, and still less to bruise them with the hands. We collect them on the small tables; we clear away as quick as possible all the litter with a broom, in baskets, which are taken away as soon as they are filled, in order to replace the worms and distribute some leaves to them again. The worms scattered in the empty places under the arches, ought to be so arranged as to be able to rise conveniently. During these last moments we should watch with attention the state of the air in the atelier. It must be continually refreshed by means of ventilators, opening of the doors and windows. By means of a fire in the chimney we shall keep it between 16 and 17 degrees. (Reaumur.) * When once the worms have arrived at their complete perfection, and it is perceived that they nearly all seek to rise, we finish by making a thick hedge, interposing fagots between those which are already fixed and to remain, in such manner as to present to them the greatest possible surface, adding constantly new ones, laid one across another. The great

* A degree of Reaumur is equal to 2 1-4 Fahrenhait—and, the freezing point of Reaumur, (corresponding to 32° of Fahrenhait) being 0, 2 1-4° of Fahrenhait, counted from 32 will give the degrees of Fahrenhait, for any given degree of Reaumur. Thus, 16° of Reaumur is 36° Fahrenhait counted from 32°=68°,—17°=70 1-4°,—18°=72 1-2°,—19°=74 3-4°,—20°=77°. In this volume the temperature is marked by Reaumur, in all cases.

object in this last operation is to avoid double cocons. We ought to take all means to prevent them.

Whatever attentions we have been able to give in raising the silk worms, there will always be found some which have not the same vigor, and rise with great difficulty. It is necessary immediately to separate them, and to transport them to a dry place, to attend upon them patiently; for often heat accelerates them. Although, when heaped together, the great moisture they exhale puts an end to their life, it can never become hurtful, if care be taken to establish a current of warm air sufficient to dry and destroy it. With watchfulness and care we shall not lose scarcely any. Finally, every thing is achieved by passing the broom everywhere over the hurdles and boards for the last cleansing, and to carry away promptly to the muck heap all the litter collected. In fine, till the fifth age is wholly ended, there are still particular cares and attentions which must not be neglected. Such are the following: The heat of the atelier must continue to be elevated and maintained to 16 or 17 degrees, the air must circulate freely in every way, and by currents renewed frequently enough to remove the abundant humidity that they continually exhale. We must collect all those who have by accident fallen after having mounted on the small fagots. When they are sufficiently protected by the thickness of the cocon, there will be no more danger in leaving them exposed to the open air. So we may refer to the following propositions, all that has been said relative to the silk worms during the ages that we have passed over. 1st. not to subject them to any conditions that may disturb the healthy state of the matter which produces

the silk, and which they hold in reserve in the secretory organs. 2d. to preserve them in a state of permanent dryness, to the end that the whole surface of their skin may retain the contractility necessary to their preservation. 3d. to keep them constantly in a current of pure atmospheric air, proper to preserve their transient life in a constant equilibrium, and not to expose them to become sick by the unwholesome effluvia that they are apt to hold in suspension, in the last periods especially, when they need to be in a vigorous and perfectly healthy state. 4th. the temperature which is necessary to them at the time of forming the cocon ought never to exceed 17 degrees. Higher than this it dries them too much, and the silk loses its quality, and especially its fineness, by cause of the heat in which the worms have been kept. It should always be held from 16 to 16 1-2, rarely to 17.

We may know that the fifth age of the worm is completed, when we press the cocon with the fingers, and perceive some resistance—when the whole envelop is firm, hard, more or less resisting. Then they quit their first envelope and become chrysales. This is the beginning of their sixth age.

If we consider the enormous quantity of vaporous, aeriform fluid that the silk worms exhale—if we examine with attention all the excremental matter they throw out, in proportion as they come to their complete growth, and till after the full termination of their cocon, we shall not be surprised to find so many causes of disease acting on them. For besides the fragments mixed with the leaves, and all the small branches mingled with excrement—besides the infectious air, and all the other unwholesome conditions that may

result from the situation and particular arrangement of the atelier, it has been ascertained and proved by certain experiments, that if three hundred and sixty worms united, at the period of their vigor may weigh three pounds and three ounces, that three days after they will not weigh more than two pounds seven ounces, and finally, after their cocons they will not weigh but a pound and a half. All the rest is evaporated in various ways, either by exhalation or by evacuation of more solid matter. It will not, then, be astonishing, that in permitting to remain about the worms so many matters capable of passing to a speedy putrefaction, they may very easily contract diseases, at the very moment even that they begin to give confident hope of an abundant crop. We cannot therefore take too many precautions to preserve them, and not to let escape the fruit of the cares which they have cost.*

VI. SIXTH AGE.

It begins at the time when the silk worm is changed to a chrysalis, and ends at that when the moth comes out, after having left his envelop in the cocon, where it is found united with what formed his skin before this change. All those that are vigorous and of good constitution finish the cocon in the third or fourth day, departing at the moment when they first secrete their saliva. However, this lasts not so long when the temperature is very elevated and the air extremely dry, as when it is the contrary. And this work is much

* The French livre is equal to 1 lb. 2 oz. Eng.—or 16 lb. Fr. is 18 lb. Eng.—6600 lbs., the quantity above given to 5 oz. of worms, will be, therefore, 7425 lbs. Eng. [Trans.]

longer, if the worms are in the least degree languishing, or have been exposed to sudden changes of heat and cold—to too long continued moisture, or have respired an air charged with unwholesome miasma—or, in fine, when a great part of them have mounted the branches at different times, in consequence of their first direction not being well combined. Therefore, to gather the cocons, we must await the eighth day, counting from the time when they begin to rise, when also they lose something of their weight. We proceed, beginning with the lower hurdles and passing successively to the middle, and thence to the highest. We can much more easily reach all those situated out side the small fagots and round about them. The greatest attention must be given to the manner of detaching the branches loaded with the cocons. They must be deposited one after another, without receiving any shock, and without throwing them or letting them fall, because we may thus wound the chrysales they contain, or cause the death of the worms that have not yet finished, which will not fail to spot the cocon. We pass them successively to each of the persons charged with detaching them, placing them before them, so that they have only to take them and place them in the baskets which were before disposed between each of them. When the fagots are unloaded, we heap them together in bundles, to use them again, or to cast into the fire, if they are not worth preserving. All the cocons which have not the requisite consistence, should be carefully separated; for those designed for sale ought to be also well selected: the others, though a quality a little inferior, cannot be used but in domestic works. We cast the cocons on

the hurdles as soon as they are detached, and for the better inspection place them at a suitable height. We must take care that all be finished at the same time, both inside and outside.

We strip them as quick as possible of the floss which they have about them, which is produced only by the saliva of the worm shed before his true silky thread.

The number of persons to be employed to finish expeditiously all the labor relating to the cocons, depends on the greater or less quantity that is obtained of them. The important thing is not to overlook any of them, and to disencumber them completely of their floss, to give them the condition required by the purchasers. After having separated those we wish to preserve for eggs for the next year, we choose them commonly small, of close texture, yellowish, approaching straw color, hard and firm at their extremities, with a kind of binding or constriction in the middle. We consider it useless to shake them, to be assured of the existence of the chrysalis, because it is proved that all the worms that have been well raised, that have formed their cocons when in vigorous and perfect health, are in a state suitable to give good moths.

Although there are no very certain signs by which to know, on inspection, what cocons will furnish male moths, and not female, we are assured, however, that the smallest, having one or both ends pointed, with a marked constriction in their middle, contain the males—that those of the females are, on the contrary, well rounded toward their ends, thick, short, loose, and without any constriction in the middle. But all this is so vague and uncertain, that it is not rare to meet

the indices of which we have spoken in the one as well as the other, and that they cannot establish any thing but presumptions.

The cocons designed to furnish eggs for the ensuing season, should, after being chosen, be kept in a dry place, and in a temperature of 15 to 18 degrees: higher, the moth comes out too soon: lower, it comes too late, which is equally injurious. We strip the cocons of the floss which envelopes them, to facilitate their egress, placing on one side those that we think females, and on the other those that we suppose males. They should not be thicker than three or four ranks, one over another, and sufficiently distant for the air to circulate freely in the interior, and not to have need to remove them often. In general, all the time that we are attending on the worms, their chrysales, and their moths, we should always keep them in a middling rather than in an atmosphere of very high temperature.

We think, generally, that during a time of greater or less length the cocons lose something of their weight, and that afterward they become somewhat heavier. All the changes that happen to it depend only on the approach of the change of the chrysalis to the moth, because that then it disengages a very large quantity of moisture.

VII. SEVENTH AGE.

The birth, the coupling of the moths, the laying of the eggs and their preservation, form the completion of the ages of the silk worm. From the moment when we perceive one of the ends of the cocon to be moist-

ened, the moth is formed. He comes out in some hours. Frequently only one is necessary, to give him time to pierce his envelope and disembarrass him of it. It will be very useful if when he gets his head and fore feet out, he may find some slightly rough surface to facilitate his egress, either by disposing the cocons in layers, with care to fill up the interval separating them when the cocons from which the papilios have gone are taken away, or by placing them on a table that has not been planed, and whose surface is unwrought and rough.

A moth may, according to his particular strength, last ten, twelve, or fifteen days at most, supposing always the atmosphere in a mild state and of middling temperature. Notwithstanding his wings, he canno take the least soar, nor raise himself in any manner. We must then dispose them in such way that we may be certain to obtain eggs having all the necessary qualities. Thus the place should be, if not completely dark, at least only light enough to be able to distinguish objects. As soon as the sun is above the horizon, we see them come from the cocons, at first in small number, during the first hour. They increase in the second, and successively from the third to the fourth. The males are hardly out when they seem to manifest a desire for coupling. We place them on pieces of cloth capable of being changed when spotted. We dispose them on tables, and arrange them in a dry place, well aired, and dark. Those that are not together are brought together, one with another, to join the first. As much as possible we must note the hour of coupling, because that after they have continued six hours, we should, taking them carefully,

separate them. All those that are left without coupling will be shut up in boxes, until there is opportunity to approach them to form other couplings. Caution is to be used in letting in the light to see what passes in the place where the moths are, for it is a stimulant to them which it is difficult for them to resist, and which by making them beat their wings, dries them, so to speak, by the loss of the powder which covers them: but when they are in a low degree of heat we must watch the successive birth of the moths as well as of all the couplings which result from it. Thus in observing the procedures which have been indicated, we shall obtain the following advantages. All the moths that come out, being separated for some hours before their coupling, may disencumber themselves of all whatever they are surcharged with. When they couple of themselves on the tables, if we take them up we do not approach them but once : they remain in a state of perfect tranquillity during the whole time that the act of reproduction continues. As for those which are not coupled, if we wish to put them on the cloths we need not also approach them but once. As for those who, after the others, remain single, isolated or placed in the box, we do not approach them but once, after having found those who have failed to couple.

Whatever may be the number of moths obtained, it is certain that we find among them often more males than females, and at other times more females than males. In the last case, we separate the males, without injuring them, at the fifth or toward the sixth hour after they have been coupled, to give them to those who have not had the males. At the moment of the laying we move them on pieces of cloth or papers pre-

pared beforehand, placing them in such manner that we may take them and change their place whenever there shall be need. If for this labor we would use a horse (or frame) of which M. Dandolo has given a description, (fig. 28,) a glance will be enough to comprehend and see that the cloths, cut into sections and united by crossing, may receive the female at the time of laying, and preserve the eggs in the order and arrangement suitable for being kept, folded and rolled on one another, till the time it will be necessary to hatch them. The most common duration of the laying is from thirty-six to forty hours. All that come after can hardly be valued at a sixth part of what the female may give, and they are thinly scattered. All the parts of the cloths or papers that are not loaded with eggs, will serve to replace others in order to fill the intervals, and distribute equally the general laying. All the eggs, which at first are more or less yellow, become reddish, and afterward have a slight tinge of blue, approaching slate. They pass alternately to these different shades in a space of eight or ten days, and at the twentieth they are as they will continue, lenticular, with a slight depression in the middle of their surface.

To preserve them, they must be kept at first during some time in a temperature of 15 to 16 degrees. Then to dry well all the matters that have been secreted with the eggs, we roll up the papers, fold the cloths in squares, and deposit them on a board, which we suspend in a place, which, during the winter, will not have a temperature below zero, and will not pass the fifteenth degree above. From time to time we put them in the air, if it is only to prevent their alteration, inspecting them at least once a month. We

must prevent also their moisture, which more readily occasions loss, than all the rest of the inconveniences that have been mentioned. For when the eggs are not well taken care of, when they are imperfect, the maladies of the silk worms, to which they are subject after hatching depend very much on not having the temperature, during the coupling and laying, higher than 10 or 12 degrees. Those that have not been impregnated are of no importance; we do not speak of them. But those which have been in an imperfect manner, produce only worms that perish in the raising.

The same happens when the temperature has been raised too high, that is to say, to 20 or 22 degrees: too much haste on the side of the female, so that she had not had time to empty herself; retarding the male, who thereby is enfeebled beforehand,—these are the only causes of it. All this cannot take place when the papilios are kept in an atmosphere of 16 to 19 degrees—when they are constantly dry—when in case of working with large quantities, not more than an ounce of eggs are spread, on a surface of three feet square on the cloth, which, for the rest of the time that we preserve them, should not be folded in more than six or eight foldings: finally, when the whole is conveniently placed on boards suspended with cords, such as have been mentioned above.

CHAP. VII.

OF DISEASES OBSERVED IN SILK-WORMS, DURING THE TIME OF RAISING THEM.

Although we are persuaded that the silk worms will never be affected with disease if they are kept always in conditions suitable to them, it is nevertheless necessary to enumerate here all the maladies with which they may be attacked. We borrow them from the Cours d'Agriculture of the Abbè Rozier.

OF THE ROUGE.

A malady so named because of the red color, more or less deep, that the skin of the worm exhibits at the moment, or soon after he has come out of the shell. The worms attacked with this disorder, appear torpid, and as it were struck with asphyxia. Their rings dry up by degrees, and they look like true mummies. Their red color becomes white. This disorder is not always fatal to the worms that are attacked by it, in the first age, nor even in the following ages. Sometimes they do not die till the fourth moulting, when they have consumed the leaf to no purpose. If their life is preserved to this period, they do not retain their red color. It will be easy to distinguish them, and to separate them from the others. They assume a much clearer tint, which makes them distinguishable by an

eye accustomed to observe them. Sometimes they go till they have mounted, and make cocons of no value, which are commonly called *cafignons*, because they are soft, and poorly spun.

OF THE VACHES, FAT DISEASE, OR JAUNDICE, MORE COMMONLY GRASSERIE.

Some writers divide this malady into three sorts; but the specific characters they give it, do not seem to be distinct enough to make us of that opinion. It may be that a variety of names for the same malady, in the different districts of country, is the cause of this division into three sorts. I agree that in one country it may present some circumstances, that we shall not observe in another. Notwithstanding this, I continue to think that this disease is the same, with some slight modifications, insufficient to give it a character that may essentially distinguish it. These are the true characteristics of this disease. 1st. The head of the worm is swollen. 2d. The skin covering the rings has the glossy appearance of varnish. 3d. The rings are bloated. 4th. The circumference of the respiratory organs is yellow, more or less deep. 5th. The worm sheds a yellow water which appears such on the leaf. It exhibits itself commonly at the second moulting. It is rare at the others, and most so at the fourth. M. Constant de Castelet says, that this malady is occasioned by a viscous and acid liquor, which enters the two vessels or sacs which the worms have in their sides, and which being mixed with the gum with which they are to form their thread, opposes

its formation and consistence, and causes a general tension in all parts of the insect, which makes his feet lengthen. Soon after, they become soft, when they shrink up and die on their litter. The acrid humor that comes from them kills all the worms that it touches. Those who are attacked with this plague seem to know this; for they fly from the others, and withdraw themselves to the edge of the boards. If they have not time or strength to reach it, they die in the midst of the litter. Those who are well, fly from them also and retire apart. When we perceive that some worms are attacked with this malady, we should be cautious lest they should communicate it to others. We must then examine them with attention, and, on the least doubt, take those we believe to be attacked and carry them to the infirmary, where the change of air only may recover them, if the malady has made but little progress. As to those which are known to have the disease really fixed, there is no other expedient to adopt but to throw them into the dung heap, and cover them, so that the fowls shall not eat them, which may poison them.

MORT BLANC.—WHITE DEATH, OR TRIPES.

M. Rigaud de Lisle, a resident at Crest, is the first who has distinguished this disease from others. The worm, says he, being dead retains his appearance of health: it is necessary to touch him to know that he is dead. Otherwise we cannot better compare it than to tripe.

THE HARPIONS, OR PASSES,—(GRIPES.)

These vulgar denominations have passed from the southern provinces to the north, as the raising of worms has become known in the latter. The word *harpion*, is derived from the word *claw*, or *talon*, and *passé* from to suffer. This disease is not really distinct from the rouge; it is but a modification of it. That manifests itself in the first days after the birth of the worm, by a yellow color. This of the *passés*, is a little more deep. See what has been said of the rouge. These two last diseases, that is to say, the worms that we call *harpions*, and *passés*, become such by the same causes which give rise to the disease we call the *rouge*. The sick worms are known, 1st. by their color, drawing toward yellow. 2d. They are lean, their skin is wrinkled, and they are shorter than others of the same age. 3d. Their feet become lengthened, slender and hooked. 4th. They eat little, languish, and are in a state of decline. When there is any *passés* after the first moulting, we may make the attempt to nurse them in the infirmary, but as they will never be well, it is best to throw them away. And if, before the first moulting, we perceive that the brood is entirely infected with it, we must have recourse to new seed.

LUZETTE, LUISETTE, OR CLAIRETTE.

The number of worms attacked with this malady is commonly small. It appears after the moultings, but especially after the fourth. It does not proceed from

a defect in the brood, as some pretend. The cause of it must be attributed to some defect in the coupling and laying. The worms attacked by this disease, eat like the others, and increase in length equally with them, but not in thickness. The disease is manifested by the color of the worm, which becomes of a clear red, and afterward of a dingy white. Observing it with attention, we perceive that it lets fall a drop of viscous water, stringy, and that its body is transparent, which has given it the name *luzette*, a name commonly given to the insects that shed light in the night. When we discover luzettes on the tables, we must throw them away. These worms eat the leaf, and are not able to wait to make the cocon. After the fourth moulting we find sometimes luzettes inclined to make their cocon. They have much motion, and go from one side to another to find where to place themselves. We must not wait till they are exhausted by their running about, and lose all their silk. When they have arrived to this point we must profit of it, and place them in baskets where there are dry boughs or in cornets of paper.

THE DRAGEES.

This is not a disease of the silk worm, since the cocon is already made when it is called *dragée*. A dragée cocon does not contain a chrysalis, but a worm short and white, like a sugar plum. Hence comes the denomination. If the worm after having made his cocon, has not been able to change into a chrysalis, it is a proof that he is sick. But what sort

of disease is this? No person has yet been able to distinguish its symptoms. We find whole broods, of which all the cocons are infected with *dragée* for the most part. But, for the rest, we need not lament it; the silk of the cocons is of as good quality, as that of the others. We shall not experience any loss, except in selling the cocons, because they are very light, But if we reel them for our own profit, they will be equal. We know a dragée cocon by shaking it. The worm dried and enclosed makes a dry sound, which the other cocons do not give.

Some other remarks on two maladies which seem to be not wholly the same as those that have been mentioned, have been published by M. Dandolo. They are those called in Lombardy *calcinaccio*, which, however, very much resembles the dragées, and *gattina*. The first, says that author, is not a disease that is observed in other worms, not even in the caterpillars that live in the open air, which leaves no doubt but that it is an effect of bad treatment. This malady results from a particular disposition which may change the whole composition of the silk worm in all the periods of his life. The causes which produce it are such that sometimes it declares itself at once, and sometimes it remains concealed till the moment when the worm seeks to rise, and even till after he has made his cocon. It becomes general in an atelier, or is confined to a few worms, according as the cause which produces it is extended or restrained. But it is not always contagious. A worm dead by calcinaccio, put in direct contact with a worm in good health, does not act upon him at all. M. Decapitani having expressed

his opinion that *calcinaccio* was a catarrhal affection, produced by a suppression of respiration, M. Dandolo makes the ten following experiments:—

1st. He placed the silk worms of an ounce of eggs in the upper story of his establishment, and left them exposed to all the changes of atmosphere, which were great at that time, up to the moment when they sought to rise. Many of them perished but none of calcination.

2d. The silk worms of an ounce of eggs were removed, after the first moulting, into a small atelier, and brought up to the fifth day of the fifth age without ever renewing the air. Not a worm was affected with *calcinaccio.*

3d. In the same atelier were placed a certain number of silk worms in boxes after the third moulting. The air was vitiated to such degree that it contained no more than seven or eight hundredth parts of oxygen. The worms nearly all died, without exhibiting any signs of *calcinaccio.*

4th. A certain number of silk worms passed through their first moulting, were raised at ten degrees of temperature, and there was care taken to make them pass gradually to this degree. They were double the time in arriving from one moulting to another. At the fourth, they had only half the weight of those which are raised at the proper degree of heat, though they were as long as the common measure. There was great inequality in their labor, and one part was affected with a disease known under the name of *gattina*, of which we shall speak hereafter. The cocons did not weigh nearly two thirds of the common weight, and there was not a single worm affected with *calcinaccio.*

5th. The silk worms brought up in 14 degrees of temperature required 45 days from their birth to the fifth moulting. Two thirds died. They never had an appearance of health. They would never have risen, if the temperature had not been elevated. The few cocons they had, were of a middling quality; there were many of them small; they were very light. No worms were attacked with *calcinaccio.*

6th. Worms raised in 15 degrees of heat took forty days from their birth to the completion of the fifth moulting. They exhibited little vigor; they sought warm places; many perished in raising; the cocons were light; but there was no *calcinaccio.*

7th. After having chosen some worms in bad health, he exposed them to a high temperature, in order to excite again their respiration, and, according to the common opinion, to guard them against the disease of *calcinaccio*, that was supposed to have already commenced. The temperature was raised by degrees to 25 and 30 degrees. The worms did not sweat. Those that were really sick, died without any distinct symptoms of *calcinaccio;* the others passed over the course of their life with regularity.

8th. Some silk worms were kept very thick on the hurdle during the whole time of their raising. They nearly all died, without showing signs of calcination.

9th. Some silk worms, hatched spontaneously, had been raised, some in a low temperature, some in a high. At each moulting many of them perished, and of three thousand nine hundred, there did not remain at the moment of raising but two thousand six hundred; a great portion of which were small and sick. There were but twelve hundred cocons of good quality.

10th. Finally, the silk worms hatched from half an ounce of eggs produced by moths that were affected with *calcinaccio*, were raised with usual care. The whole course of their life was regular. They were fine up to the time of rising, and made good cocons. M. Dandolo then remarked to those who were surprised at this phenomenon, that one need not fear maladies coming by the fecundation, but when it takes place by papilios of feeble constitution, or when there has not been the necessary care in obtaining or preserving them.

As for the change or rather the degeneracy of the silk worm in *gattine*, this is a real malady peculiar to the insect, and perfectly like that to which all living animals may be subjected in consequence of bad food, or by water or air filled with deleterious substances, want of care—finally, by a bad original conformation of organs. We designate under the name of *gattine* every worm which is unable to accomplish the functions to which he is destined, according to the degree of change that he has experienced. He shows himself different from the sound silk worms; he is restless at whatever age the disease commences; he does not choose to live near others; some lose their appetite; others, after having eaten well and lived a time of more or less length, die out of the hurdle, or even on the litter, if they are taken suddenly with the disease. We think there may be three causes capable to produce it. 1st. The adulteration of the worms when hatched, from having been badly kept, or carried far without precaution. 2d. If we have not proceeded right in hatching the eggs in the hot-house. 3d. If after their birth good care has not been taken of the worms;

that is to say, if they have been left a long time in a temperature too cold, or if we have neglected to take all necessary care during the moultings. There is never any sickness when the egg has been well fecundated, well preserved, and the silk worm well taken care of during all the time of his raising.

Thus the diseases of the silk worms have their origin in the particular mode that we are in habit of following, in raising them; such are imperfect att empts to keep them sheltered from the contact of the air, which makes them heap up in the frames or ateliers, very often too narrow for their numbers. As he atmosphere there is almost always without elasticity, they soon lose their appetite and fall into a state of stupor and languor. The air that surrounds them is saturated with and holds in suspension all the perspiration that escapes from their skin, passing it rapidly into fermentation; it acts also so much the more speedily, as the animal that is exposed to it has organs more feeble. Such is the cause of the *touffe*, which, when it is also aggravated by the heat of summer, by the putrefaction of the litter, by the exhalations from it, becomes the most terrible plague, and the most destructive to silk worms. Next appears the *muscardine*, a disease in which the worm dead in a state of softness and flaccidity, dries up in a short time without losing any thing of his form.* He becomes sufficiently hard to be preserved a long time, if not exposed to moisture. I we examine attentively the worms that are attacked with it, we find them in a

* This seems to be the same or a similar disease to the *calcinaccio*, before named, in which the worm is calcined or reduced to powder.

state of heaviness, of immobility, of loathsomeness, of softness. Although without any particular index of this condition we perceive some become *muscardins*, others *morts blancs*, or *morts flats*. It is necessary to take the more care, as the muscardine is epidemic, and as the worms taken in a healthy chamber and put in contact and mixed with the other sick worms, have nearly all contracted the disease and died. But the contagion is not declared till after several days of communication and mixture of the sound worms with those that are sick. It is also certain that it cannot be transmitted by the tables on which it has prevailed, and still less by the worms who have died of it. In the number of silk worms there are found some more robust than others, and who draw out imperfect cocons, fouled with a brown liquor of a nauseous odor, which has caused them to be called *fondus* (melted); others, after having climbed on the faggots, cannot continue to spin, and remain there suspended. They are known by the name of *capelans*.

CHAP. VIII.

MEANS OF REMEDYING THEM.

In all these kinds of diseases we have not discovered any difference in the causes capable of producing them, and silk worms have been preserved under exposure to all contrary circumstances; to the open

air, even to pretty sharp cold, to often repeated neglect, to eat decayed leaves, to suffer, some by famine, often to be left to breathe, for a long time, a corrupt, vitiated air; while they are spread on litter half putrid, while the atmosphere with which they are continually surrounded is suffocating, and in no way fit for respiration, while the rainy season does not allow to give them also any but moist leaves, or even wet, for their daily nourishment, at the time when they have most need of them. The essential thing in such circumstances is to employ all the means capable of renewing the air of the atelier. Such are fumigations with muriatic acid, the process and theory of which we owe to M. Guyton de Morveau, and the object of which is to purify the air infected by putrid or contagious miasmata. They may be made in different ways, as simple as they are easy, very little expensive, but which should vary according to circumstances: first, If we have to purify a hall, or a place which is not inhabited, we set in the middle of it a warmer with lighted charcoal, on which we put a stone, or earthen vessel of suitable size; we throw in it three ounces of common sea-salt coarsely broken; then we pour in it, at a single time, two ounces of sulphuric acid, the oil of vitriol of commerce. There soon arises from this mixture an acid vapor very expansive, which spreads into all parts of the room, and will produce coughing and irritation of the eyes and throat, if we remain exposed to it. We must then, after having poured the sulphuric acid on the salt, retire immediately, shut the doors and windows of the room, and not enter it again till after some hours. We repeat this fumigation several times, if necessary,

and increase the quantity of the substances, if the place be large. Second, If we would purify the air of an atelier or coconery, or any other place in which we may be obliged to remain during the fumigation, we can do it in a more easy and slow manner. We take a small portable stove on which we place an earthen or stone vessel; we put in it, as before, some sea-salt; we pour on it, little by little, the oil of vitriol, in order not to have, all at once, a great disengagement of muriatic acid gas; and we move this small apparatus about, to the different parts of the room, which may be repeated more or less often as there is need. Third, We may increase the energy and efficaciousness of these fumigations, by mixing with the quantity above indicated of sea-salt two drachms of black oxide of manganese in fine powder. Fourth, We obtain the same result without employing fire, by putting in a capsule, or large bottle of glass, earthen, or stone, four ounces of muriatic acid (marine acid, spirit of salt,) two drachms of black oxide of manganese in powder, a half drachm of nitric acid (aqua fortis of commerce.) There immediately arises from this mixture a volatile gas very expansive, very penetrating, the expansion and disengagement of which is regulated by stopping closely, the vase or flagon containing the mixture. Fifth, Finally, the preferable mode, because the manual is most simple, most easy and in reach of every body, we may, for the daily use of a coconery or atelier, prepare beforehand in the proportions indicated, a mixture of sea-salt and manganese, and have some sulphuric acid in a separate flagon. Whenever it is necessary to make a fumigation, all that is to be done is to put in an earthen ves-

sel some pinches of the powder or saline mixture, and to pour on it, successively by drops, a small spoonful of the acid.

To understand what is the mode of action of these fumigations, how they are efficacious to destroy all infectious and contagious miasmata with which the air may be charged, it will be sufficient to observe that the muriatic acid gas is the most expansible, the most penetrating of all the gases, and also, that it is very greedy of combination. When, therefore, this gas is disengaged, is disseminated through the air, kept, restrained within the interior of a room, it seizes immediately the miasmata that it meets, and by consequence destroys their unwholesome properties, forming with them new compositions. But beside this chemical effect, well demonstrated by experiment and observation, as after these fumigations the air of the place remains a longer or shorter time impregnated with a certain quantity of muriatic acid gas, very perceptible by the peculiar odor it retains, it becomes to those who breathe it a powerful stimulant to excite the action of the organs, to increase the vital energy of the solids, and to change the composition of the fluids. Thus these fumigations should be considered not only as a preservative, disinfecting means, proper to deprive the air of the contagious miasmata with which it may be charged; but also, used with skill and suitable precautions, they become valuable auxiliaries in establishments for raising silk worms.

From the foregoing remarks, it is evident that fumigations with muriatic acid are applicable every where and in every case, where the air is corrupted by miasmata or putrid exhalations. So it may be em-

ployed with the greatest advantage during the emptying of vaults, to decompose the fœtid gas that is disengaged from it, is spread through the whole interior of the dwelling, and often attacks the life and health of the workmen engaged in the labor. It may be employed with the same advantage in fabrics and manufactures, where we work in animal or vegetable substances which pass into putrefaction, in the ateliers of silk worms—in fine, in all places where the air is infected by collections of animals, by the excretions that come from their bodies, or by the vaporization of different substances that they continually secrete during their life.

CHAP. IX.

MANNER OF STIFLING THE CHRYSALIS IN THE COCON, AND OF REELING THE SILK.

In the first days after taking them from the branches, after having selected all the cocons, from which we wish to have the moth (or papilio) for seed, we should occupy ourselves with stifling those that remain. To accomplish this without injuring the thread which forms its texture, we have recourse to many processes. We shall relate here the principal. Sometimes the vapor of camphor, of turpentine, and of sulphur has been used; but all the modes of using it, being more or less expensive, often present difficulties

so great, that these processes are in fact almost wholly abandoned. Recourse has been had to heat, and the cocons in which the chrysales were to be killed, have been exposed, during five or six days in succession, to the rays of the summer sun. This is sufficient when no interruption happens. The cocons have also been subjected to a bath, continued for some minutes in boiling water. But the difficulty in drying them equally when they have been taken out, and the softening of the chrysales, which afterward passes to putrefaction, and spoils the silk, has caused this to be abandoned. Their exposure to the heat of an oven in baskets, or drawers, has been tried, by heating the bottom, which is of sheet-iron. But this procedure has with it also the inconvenience of crisping the surface of the cocon, and hurting the silk. It is, nevertheless, most generally followed by the majority of persons; and they take advantage in this way of the heat that remains after baking their bread. But the sweating of the chrysales, and the scorching of the cocons, make the exposure to the rays of the sun preferable. We lay them out on cloths in their beds, and leave them there during four or five hours of the greatest force of the rays.

But by the mode of M. Dhombres of Alais, whose apparatus is formed of chests of copper, in a cabinet supporting drawers with canvass bottoms, he obtains a heat free from the acridness which the contact of iron or of a solid body too strongly heated always has. It may be varied and regulated at will, by means of a thermometer. The vapor of boiling water acts indirectly in this stifling apparatus. The copper chests two inches deep, form in a cabinet the support of

drawers with canvass bottoms in which are contained the cocons. The heat introduced into the upper chest at one of its corners by aid of a neck, (or mouth,) which is fitted to a tube separated from the copper, descends into the next chest by a pipe placed in the opposite diagonal corner, and so from story to story to the last. With ten drawers in place, and four others for change, containing twelve kilograms of cocons, arranged in beds of four inches thick, he can in an hour stifle from four to five hundred kilograms. But this apparatus will be so costly, that it can only be used in a large establishment.

We have seen the chrysalis of white cocons die in less than a half hour with a heat of seventy-five degrees, without the cocons having experienced any deterioration either in their color or texture; only their weight was diminished about one seventh. But all the methods make a like reduction; even exposure to the heat of the sun, which has been found good when the season is warm and propitious; for it is still to this last that we give the preference, as the most simple, most easy, and least expensive.

To wind and reel the cocons to make skeins of a uniform and continued thread of silk, which constitutes tram, we have recourse to a mechanical operation, which requires the aid of warm water. We moisten the cocons with it, in order to soften them, and deprive them of their floss. Thus, after having chosen them, when we have separated those which are double, after having put aside those that are imperfect and badly made, they are exposed to vapor in order to liquify their gummy substance, which keeps them together in the cocon. Of all the modes used to obtain

this result, that of M. Gensouls is the most followed wherever silk worms are raised. It consists in the use of a tube of greater or less diameter, which carries, horizontally, the whole length of the atelier the vapor of boiling water; then, by means of a cock placed in reach of the reeler, she may heat at will the water she needs, by a pipe which is there insered, and led into the principal conduit. By this mode she need not suffer, as by the common furnaces, the heat of a burning fire; the smoke which arises from it, as inconvenient, as painful to the eyes, is not, in this mode, to be feared: it does not tarnish the whiteness of the silk: there is no need of stirring the fire to keep it up: five or six minutes are sufficient to raise the water to sixty degrees, and even more if required; and all the silks reeled by vapor are as good, as strong, as elastic as by any other process. Beside the economy of fuel, we can also substitute for the copper basons vessels made in the same form of wood, which will be still less expensive.*

Immediately behind is placed the winding-mill. It is a frame composed of four pieces of wood put together and bound by traverses; in their centre is an iron axle, on which is fixed a reel with four wings grooved, the upper of which is smooth and rounded. The motion which the reeler gives to it by means of a handle is communicated to two pullies by two claws or vertical shanks, the upper end of which is a spiral. Placed at the front part of the mill, they sustain the thread of silk rising from the bason to the

* A method of reeling by steaming the cocons, has been invented by Mr. T. G. Fessenden, of Boston, described in the silk Manual. [Trans.]

top of the reel. By means of these shanks, attached to a traversing rod, the silk is prevented from coming always on the same point on the reel. As in the most common reels, it did not return to the same place till after eight hundred and seventy-five turns of the great wheel of the reel, and this was too frequent, because it had not time to dry: other machinery has been supplied, by means of which the thread cannot come to the same point till after the two thousand six hundred and first revolution. Thus the moisture is no more to be feared. "The pulley attached to the axle in the ordinary reels, acts, in the new apparatus, by a cord without end on a second double pulley, encompassed with a third, which is fixed to it, and which, of consequence, follows it and goes through the same revolutions. A second cord without end, which passes in the groove of this third pulley, communicates its movement to the fourth pulley, which moves the traversing rod. It is in the proportion of the different diameters of these wheels, that all the difficulty of the process consists; for the last pulley makes a thousand nine hundred and thirty-six turns, and the first two thousand six hundred and one, before they come again to the same point." It has also been conceived to line the claws with cloth, so that the friction produced by it shall deprive the thread of wisps, of loops, of knots, and of whatever might make it imperfect; by consequence of which the reeling becomes useless, the silk is drawn out and doubled. We avoid of course all these manipulations.

The reeler, seated before or at the side of the reel, and of her bason, casts into the water it contains a number of cocons, more or less, always proportion-

ed to the kind of silk she wishes to obtain. She takes from five to twenty, to form a thread: she crosses the silk, twisting at the same time two threads in such a manner that she may reel them on the frame in two separate skeins. By running one over the other, the crossing and friction makes them stronger, and more round and smooth; but to avoid the inequality produced by the difference in the turns given to the same silk, there has been substituted, for the shanks, a wheel set in the middle of a circle, and pierced with two holes in its diameter, which receive the threads, on coming from the wires, and by the rotary movement, which is given it by a packthread, whose length is measured by the number of turns the wheel must make, the threads are crossed any determinate number of times.

Before commencing work, the drawer has passed over all the cocons that she has cast into the water in the bason, a small broom, very short, made of birch or broom, to separate the floss, and the coarse tram, which she takes off and puts aside. Then the end of the thread appears, which she passes, after it is loosened by the heat, through the guides, which are iron rods, in front, over the bason. The coarser thread that comes first, makes what are called cotes, [stalks.] After the first outside, she collects the threads with her fingers, twists them, crosses the end with the other skein, passes it into the guide, thence into the spiral shanks, attaching them to one of the wings of the reel. The reeler, her eyes fixed on the thread, turns the machine. She moderates it, or stops it, if the thread break, that the drawer may attach another to it, and obtain a thread, as even as possible. When

the cocon is wound off, she adds another of those that she has in reserve in the bason. All the chrysales are put aside, to be thrown into the dung heap.

In this manner we obtain silk, not twisted: this is the woof silk: the others, designated under the names of tramettes, and of organsins, will be better called fine silks. All have their particular use, either for weaving, for hosiery, for the warp of stuffs, for crape, gauze, blondes, and white tulles. The doupions or sewing silk, come from double cocons. The chiques, the skins supply silk for ribands and plush. Indeed the perforated cocons, the shells that remain after the silk is reeled off, the cotes, [stalky threads, first wound off,] the scrapings of the brooms, or of the boughs, all those cocons called frisons, moresques, prepared by beating or breaking on a stick of wood, boiled in soap-suds, after being carded and spun, make coconilles, fantasie, flurt silk and welt, generally comprised under the name of fleuret, [or ferret,] used in all work, for purposes connected with hosiery.

But, among the different denominations used to designate the quality of silk, the greatest part is only the result of the preparations or changes that it has been made to undergo for the fabrication of tissues, or various stuffs of which they form the first woof. A substance essentially gummy, the silk should have an appearance bright and smooth; it ought to be even and glossy, as the handsomest varnish. Industry, aided by mechanical process, has been able to give it the color and form necessary to the purposes for which we intend to use it.

Over all the exterior surface of cocons is spread a

silky substance, extremely fine, delicate, and light, more or less white or yellowish, which is commonly designated under the name of floss. It is this which gives, after having been carded or combed, the fleuret [ferret,] of first quality. As for the inferior fleuret or that of the second quality, we get it from refuse cocons, that cannot be reeled, and from what remains about the chrysalis of those that have been reeled. After having put together all that the cocons can furnish, it is steeped some hours in common water, which must be changed every twenty-four hours; afterward, be cast into another water, with a small quantity of potash in it, or of lye, leaving it there to soak some hours, be washed anew, and dried, in order to card or comb it, as has been said above. Whether of the first or second quality, the fleuret is then spun on a spinning-wheel or spindle; and after having undergone boiling, after having been put to the dye, whatever its color, it is called filoselle.

All silks reeled from cocons, and made into skeins, are yet far from being glossy: on the contrary, they are for the most part uneven, and full of roughness, produced by foreign substances which adhere to them. It will be impossible to use them. On coming from the wheel they are called raw silk. In this state it is used in commerce, from the first hands. Afterward, it is necessary to submit it to the mill, that it may be made even, flexible, compact, glossy and brilliant and susceptible of taking the dye. It is considered as raw, [ecrue,] when it has been simply twisted, by the mill. Boiled silks, [soies cuites,] are those that have been made to boil a longer or shorter time, to reel them more easily. Ungumming them, [decreusage,] consists

in subjecting them to boiling in soap-suds. It is also absolutely necessary, to plunge them in the dye. As for those that are prepared for making stuffs, they are generally all dressed by machinery. Tram is made of single, double, sometimes triple threads, of raw silk, formed on spindles: often to make tram, we use ovalée * silk, that is to say, twisted in many threads joined, by particular machines. As to hair silk, [singles,] it is only raw silk, prepared in single threads. Organsin, or organsined silk, is the principal thread, with which is made the first warp of all stuffs. On account of the strength it must have, because it bears a great strain, we are obliged to make it of two or more threads, twisted together with two or three turns, [reprises.] This operation, useless for tram, constitutes what is called dressing, [appret.]

The organsining of silk, is so essential to the manufacturer, that without it, it would be impossible to make any thing. It remains raw. The machine to which it is submitted, invented at Bologne, improved in Piedmont, has been carried to the greatest degree of perfection by the artists of Lyons, whose raw silks rival all others known in commerce.

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* Dressed on an instrument called an oval. [Trans.]

EXPLANATION OF THE PLATE.

SHORT NOTICE OF ALL THE INSTRUMENTS THAT ARE CONSIDERED USEFUL, NECESSARY, OR INDISPENSABLE FOR RAISING SILK WORMS.

Fig. 1. Echenilloir, worm-killer, made with two blades like those of large shears, fixed at the end of a pole, longer or shorter; they are made to act by means of a string, after having a point of support, on the branch which has the nest of caterpillars. What the gardeners called a volant may be used for the same purpose. And they use a pruning-knife when they can reach them without mounting on the tree.

Fig. 2. But if we have waited too long, and the worms hatched are scattered over the trees, we may use a pan of iron or copper, also fixed to a handle, longer or shorter, and carry it every where that the caterpillars are collected, after having lighted some moist straw, sprinkled with sulphur reduced to powder, so that they fall and are destroyed.

Fig. 3. A Scraper, by means of which it is very easy to detach the eggs of the silk worms adhering to the wet linens; which we may pass between the eggs that are fixed on them, holding it with a firm and steady hand. In this manner we detach a great many in a short time.

Fig. 4. Thermometer, an instrument of first necessity in all ateliers of silk worms. We must select those that are well made, and of mercury rather than spirits of wine.

Fig. 5. A Stove. They are made in so many ways, they have been pushed to such degree of perfection, that it will be difficult to point out those to which we should give the preference. To regulate at pleasure the heat produced with the least possible fuel, preserving the control of it so as to augment or diminish it according to need, by means of doors and dampers fitted to it; this is the end of the use of stoves to warm ateliers, in which they may be multiplied according to need and the use of the atelier.

Fig. 6. Box to hatch the eggs. They are made of various sizes: we may have them of pasteboard or very thin pine; but we must be careful to number them very plainly on all their sides.

Fig. 7. Hurdles or Boards. We cover them with paper to place the silk worms on. The best are made with cane. Their bottom ought not to be too close: the paper dries better by receiving the contact of the air above and below. Their length and breadth must be proportioned to the extent of the atelier, and the quantity of worms we must place on them. Like the boxes they should be numbered very plainly.

Fig. 8. Spoon or Spatula, with which we may remove the eggs to every side without crushing them: the form given to this instrument renders the operation very easy.

Fig. 9. Transport Tables. They must be a foot broad—be long in proportion, and surrounded on three sides only by an edging raised six or eight lines, at a medium. They are fixed with a handle, to make them more easy to carry; made of thin boards and very smooth. We rest them on the broad sides of the hurdles, so that the silk worms may rise on them without finding any obstacles.

Fig. 10. Ventilators. Every where that they can be fixed, they should be made so that the board which serves to open or shut them may slide easily in two grooves, by which it is held in place, rising and falling when the ventilator is fixed in a wall or window, and sliding on the ceiling when it is there.

Fig. 11. Punching Tool, by which we may, by striking on the upper surface, perforate a great number of sheets of paper at the same time, put together and placed on a block. We may also, instead of perforated paper, use coarse netting; it answers perfectly the object proposed, that of making the worms rise upon it, in order to place them where necessary.

Fig. 12. Iron Hook, bent so as to be able to raise the worms easily, when they are so small that there is danger of crushing them with the fingers.

Fig. 13. A Chest, to transport the worms to a distance when they are hatched, in order to continue their raising. This consists of small shelves placed one over another, which may be drawn out and replaced at pleasure. They are filled with sheets of paper, on which they are spread, and by means of corresponding slides on the two sides may be increased or diminished at pleasure. We fix to it two leather straps, so as to carry it like a tray.

Fig. 14. A Knife, large and strong enough to cut easily the mulberry leaves.

Fig. 15. A Double Cutter, which may be passed over the leaves already cut, to make them more fine, and to multiply the surfaces and edges; an operation absolutely necessary in the first and second age.

Fig. 16. A larger Cutter, somewhat like that used for cutting straw. By its means we can, in a very

short time, divide in two or three, the leaf that is to be distributed to the worms in the three first days after their third moulting.

Fig. 17. A small Broom made of millet, birch, or any other small twigs. It is useful and even necessary to distribute the leaves equally on the hurdles.

Fig. 18. Common opening in the bottom of doors. It may be opened and closed at will, by means of two slides, between which moves up and down a small trap always fixed to it.

Fig. 19. A square Basket, of sufficient breadth and depth, surmounted by a hook in the middle of the handle, by which it is made to move and act on every side, the length and in the middle of the hurdles, without falling or rubbing their lower edges.

Fig. 20. A small Cricket, serving to elevate the person that distributes the leaves on the second rows of hurdles, and prevent them being overset.

Fig. 21. A small Ladder, made so as to be easily carried about, whenever necessary in order to reach the upper hurdles. We make a number sufficient for the persons wanting them. They must be light and convenient.

Fig. 22. Barometer. It serves to show the state of the air, and the degree of moisture in the atelier.

Fig. 23. Disinfecting Apparatus. We may have it larger or smaller, and keep it more or less closely covered, according to need, by the force of the pressure on its stopper of polished glass.

Fig. 24. A Tray. Whatever its form, it must be light, convenient, and so made as not to lose or let escape the dirt or excrement that it serves to carry out of the atelier.

Fig. 25. Utensil to collect the dirt After having first cleaned the hurdles, we sweep on it, with the small broom, all that remains on the papers.

Fig. 26. A Frame on which to place and transport the moths. The cloth which is laid on it may be renewed at will. In the middle is a handle to manage it more easily.

Fig. 27. A Box to contain the papilios and prevent them beating themselves with their wings, by keeping them constantly in the dark. The cover is pierced with an infinite number of small holes, to give them air.

Fig. 28. A small Horse (or frame) disposed to put the female moths on, at the time of their laying, to collect their eggs. It is made to be opened and shut at will, in order to fill less space, and so as to be kept without trouble to be used in following years.

Fig. 29. A Frame of twine, suspended so that the air may easily circulate about the cloths or papers on which the eggs are to be preserved from one season to another. When it is conveniently situated, we keep on it the eggs as cool and dry as necessary to prevent danger of their alteration or decay.

Fig. 30. Plan of a small Atelier, (or coconry,) with a stove in the middle, and two chimneys in the corners.

Fig. 31. Plan more detailed of an Atelier large enough to hold five or six hundred pounds of cocons. It has four chimneys in the corners, two stoves in the middle, and another opposite to the door.

END.

NOTE.

BY THE TRANSLATOR.

[*Extract from New England Farmer, vol.* 8, *p.* 333.]

"Lyons, France, January, 1830. An assay of a quantity of American raw silk lately took place, by request of the Chamber of Commerce. It results that the specimen sent from Philadelphia is admirably adapted to all the uses of fabrication. Its degree of fineness is sixteen dwts., so that it would produce singles of fifty dwts., or organsin of thirty-two, or tram of thirty, a quality of silk extremely rare in our country. American silk is fine, strong, good, regular, clean, of fine color; in a word, it unites all the qualities that can be wished for. Its market price, in the state of raw silk well reeled, according to its different qualities, well prepared, would be twenty-six francs a pound, and the sale at Lyons would be very easy, particularly if there were a constant supply of bales weighing from one hundred to one hundred and fifty lbs."

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